

CONTRACT DOCUMENTS AND SPECIFICATIONS

for the

PIKEVILLE 0.366 MGD WASTEWATER TREATMENT PLANT

Prepared for the

City of Pikeville, TN



MAY 2024

HUSSEY GAY BELL

Established 1958

**CONTRACT DOCUMENTS AND
TECHNICAL SPECIFICATIONS
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- B – MR Systems SCADA Scope
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This document has important legal consequences; consultation with an attorney is encouraged with respect to its use or modification. This document should be adapted to the particular circumstances of the contemplated Project and the controlling Laws and Regulations.

ADVERTISEMENT FOR BIDS FOR CONSTRUCTION CONTRACT

Prepared By



Endorsed By



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**City of Pikeville
25 Municipal Drive
Pikeville, Tennessee 37367**

Advertisement for Bids

General Notice

The City of Pikeville is requesting Bids for the construction of the following Project:

Pikeville 0.366 MGD Wastewater Treatment Plant

Bids for the construction of the Project will be received in the office of Justin Thomas, Wastewater Manager, 25 Municipal Dr, Pikeville TN, 37367, until 2:00 PM (Local Time) June 26, 2024, at which time they will be publicly opened and read in the Pikeville City Hall.

Work to be included under this contract will include,

The Construction of a new 0.366 MGD Wastewater Treatment Plant including mechanical and manual influent screens, bypass piping, Parshall flumes, aeration basin & equipment, clarifiers & equipment, chlorination/dechlorination equipment and basin, plant drain pump station, RAS/WAS pump station, sludge digester, sludge belt press & building, electrical, SCADA, process piping, lab/office/control & MCC buildings, site work, and associated appurtenances.

Owner anticipates that the Project's total bid price will be approximately \$ 13,913,220.00. The Project has an expected duration of 730 days.

Obtaining the Bidding Documents

Prospective Bidders may obtain or examine the Bidding Documents at the Issuing Office on Monday through Thursday between the hours of 7:30 A.M. - 5:30 P.M. local time and may obtain copies of the Bidding Documents from the Issuing Office as described below. Partial sets of Bidding Documents will not be available from the Issuing Office. Neither Owner nor Engineer will be responsible for full or partial sets of Bidding Documents, including addenda, if any, obtained from sources other than the Issuing Office.

Printed copies of the Bidding Documents may be obtained from the Issuing Office by paying a deposit of \$150.00 for each set. Make deposit checks for Bidding Documents payable to Hussey Gay Bell & DeYoung, Inc of Georgia.

Bidding Documents may be purchased from the Issuing Office during the hours indicated above. Cost does not include shipping charges. Upon Issuing Office's receipt of payment, printed Bidding Documents will be sent via the prospective Bidder's delivery service. The shipping charge amount will depend on the shipping method chosen. Bidding Documents are available for purchase in the following formats:

Format	Cost
Bidding Documents (including Full-Size Drawings)	\$300.00

Format	Cost
Bidding Documents (including Half-Size Drawings)	\$300.00
Electronic download of Bidding Documents (PDF) via FTP link	\$100.00

Pre-bid Conference

An OPTIONAL pre-bid conference for the Project will be held on June 6, 2024, 2:00 PM local time at the 25 Municipal Drive, Pikeville TN, 37367.

Instructions to Bidders.

For all further requirements regarding bid submittal, qualifications, procedures, and contract award, refer to the Instructions to Bidders that are included in the Bidding Documents.

This Advertisement is issued by:

Owner: City of Pikeville

By: Justin Thomas

Title: Wastewater Manager

Date: May 21, 2024

This document has important legal consequences; consultation with an attorney is encouraged with respect to its use or modification. This document should be adapted to the particular circumstances of the contemplated Project and the controlling Laws and Regulations.

INSTRUCTIONS TO BIDDERS FOR CONSTRUCTION CONTRACT

Prepared By



Endorsed By



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ARTICLE 1—DEFINED TERMS

- 1.01 Terms used in these Instructions to Bidders have the meanings indicated in the General Conditions and Supplementary Conditions. Additional terms used in these Instructions to Bidders have the meanings indicated below:
- A. *Issuing Office*—The office from which the Bidding Documents are to be issued, and which registers plan holders.

ARTICLE 2—BIDDING DOCUMENTS

- 2.01 Bidder shall obtain a complete set of Bidding Requirements and proposed Contract Documents (together, the Bidding Documents). See the Agreement for a list of the Contract Documents. It is Bidder's responsibility to determine that it is using a complete set of documents in the preparation of a Bid. Bidder assumes sole responsibility for errors or misinterpretations resulting from the use of incomplete documents, by Bidder itself or by its prospective Subcontractors and Suppliers.
- 2.02 Bidding Documents are made available for the sole purpose of obtaining Bids for completion of the Project and permission to download or distribution of the Bidding Documents does not confer a license or grant permission or authorization for any other use. Authorization to download documents, or other distribution, includes the right for plan holders to print documents solely for their use, and the use of their prospective Subcontractors and Suppliers, provided the plan holder pays all costs associated with printing or reproduction. Printed documents may not be re-sold under any circumstances.
- 2.03 **OMITTED**
- 2.04 Bidder may register as a plan holder and obtain complete sets of Bidding Documents, in the number and format stated in the Advertisement or invitation to bid.
- 2.05 **OMITTED**
- 2.06 *Electronic Documents*
- A. When the Bidding Requirements indicate that electronic (digital) copies of the Bidding Documents are available, such documents will be made available to the Bidders as Electronic Documents in the manner specified.
1. Bidding Documents will be provided in Adobe PDF (Portable Document Format) (.pdf) that is readable by Adobe Acrobat Reader. It is the intent of the Engineer and Owner that such Electronic Documents are to be exactly representative of the paper copies of the documents. However, because the Owner and Engineer cannot totally control the transmission and receipt of Electronic Documents nor the Contractor's means of reproduction of such documents, the Owner and Engineer cannot and do not guarantee that Electronic Documents and reproductions prepared from those versions are identical in every manner to the paper copies.
- B. Unless otherwise stated in the Bidding Documents, the Bidder may use and rely upon complete sets of Electronic Documents of the Bidding Documents, described in Paragraph 2.04.A above. However, Bidder assumes all risks associated with differences arising from transmission/receipt of Electronic Documents versions of Bidding Documents and reproductions prepared from those versions and, further, assumes all risks, costs, and

responsibility associated with use of the Electronic Documents versions to derive information that is not explicitly contained in printed paper versions of the documents, and for Bidder's reliance upon such derived information.

C. **OMITTED**

ARTICLE 3—QUALIFICATIONS OF BIDDERS

- 3.01 To demonstrate Bidder's qualifications to perform the Work, after submitting its Bid and within 5 business days of Owner's request, Bidder must submit the following information:
- A. Written evidence establishing its qualifications such as financial data, previous experience, and present commitments.
 - B. A written statement that Bidder is authorized to do business in the state where the Project is located, or a written certification that Bidder will obtain such authority prior to the Effective Date of the Contract.
 - C. Bidder's state utility or other contractor license number, if applicable.
 - D. Subcontractor and Supplier qualification information.
 - E. Other required information regarding qualifications.
- 3.02 **OMITTED**
- 3.03 **OMITTED**
- 3.04 **OMITTED**
- 3.05 No requirement in this Article 3 to submit information will prejudice the right of Owner to seek additional pertinent information regarding Bidder's qualifications.

ARTICLE 4—PRE-BID CONFERENCE

- 4.01 **OMITTED**
- 4.02 **OMITTED**
- 4.03 An OPTIONAL pre-bid conference will be held at the time and location indicated in the Advertisement or invitation to bid. Representatives of Owner and Engineer will be present to discuss the Project. Proposals will not be accepted from Bidders who do not attend the conference. It is each Bidder's responsibility to sign in at the pre-bid conference to verify its participation. Bidders must sign in using the name of the organization that will be submitting a Bid. A list of qualified Bidders that attended the pre-bid conference *and are eligible to submit a Bid for this Project will be issued in an Addendum.*
- 4.04 Information presented at the pre-Bid conference does not alter the Contract Documents. Owner will issue Addenda to make any changes to the Contract Documents that result from discussions

at the pre-Bid conference. Information presented, and statements made at the pre-bid conference will not be binding or legally effective unless incorporated in an Addendum.

ARTICLE 5—SITE AND OTHER AREAS; EXISTING SITE CONDITIONS; EXAMINATION OF SITE; OWNER'S SAFETY PROGRAM; OTHER WORK AT THE SITE

5.01 *Site and Other Areas*

- A. The Site is identified in the Bidding Documents. By definition, the Site includes rights-of-way, easements, and other lands furnished by Owner for the use of the Contractor. Any additional lands required for temporary construction facilities, construction equipment, or storage of materials and equipment, and any access needed for such additional lands, are to be obtained and paid for by Contractor.

5.02 *Existing Site Conditions*

A. *Subsurface and Physical Conditions; Hazardous Environmental Conditions*

1. The Supplementary Conditions identify the following regarding existing conditions at or adjacent to the Site:
 - a. Those reports of explorations and tests of subsurface conditions at or adjacent to the Site that contain Technical Data.
 - b. Those drawings known to Owner of existing physical conditions at or adjacent to the Site, including those drawings depicting existing surface or subsurface structures at or adjacent to the Site (except Underground Facilities), that contain Technical Data.
 - c. Reports and drawings known to Owner relating to Hazardous Environmental Conditions that have been identified at or adjacent to the Site.
 - d. Technical Data contained in such reports and drawings.
2. Owner will make copies of reports and drawings referenced above available to any Bidder on request. These reports and drawings are not part of the Contract Documents, but the Technical Data contained therein upon whose accuracy Bidder is entitled to rely, as provided in the General Conditions, has been identified and established in the Supplementary Conditions. Bidder is responsible for any interpretation or conclusion Bidder draws from any Technical Data or any other data, interpretations, opinions, or information contained in such reports or shown or indicated in such drawings.
3. If the Supplementary Conditions do not identify Technical Data, the default definition of Technical Data set forth in Article 1 of the General Conditions will apply.
4. *Geotechnical Baseline Report/Geotechnical Data Report*: The Bidding Documents contain a Geotechnical Baseline Report (GBR) and Geotechnical Data Report (GDR).
 - a. As set forth in the Supplementary Conditions, the GBR describes certain select subsurface conditions that are anticipated to be encountered by Contractor during construction in specified locations ("Baseline Conditions"). The GBR is a Contract Document.
 - b. The Baseline Conditions in the GBR are intended to reduce uncertainty and the degree of contingency in submitted Bids. However, Bidders cannot rely solely on

the Baseline Conditions. Bids should be based on a comprehensive approach that includes an independent review and analysis of the GBR, all other Contract Documents, Technical Data, other available information, and observable surface conditions. Not all potential subsurface conditions are baselined.

- c. Nothing in the GBR is intended to relieve Bidders of the responsibility to make their own determinations regarding construction costs, bidding strategies, and Bid prices, nor of the responsibility to select and be responsible for the means, methods, techniques, sequences, and procedures of construction, and for safety precautions and programs incident thereto.
 - d. As set forth in the Supplementary Conditions, the GDR is a Contract Document containing data prepared by or for the Owner in support of the GBR.
- B. *Underground Facilities:* Underground Facilities are shown or indicated on the Drawings, pursuant to Paragraph 5.05 of the General Conditions, and not in the drawings referred to in Paragraph 5.02.A of these Instructions to Bidders. Information and data regarding the presence or location of Underground Facilities are not intended to be categorized, identified, or defined as Technical Data.

5.03 **OMITTED**

5.04 *Site Visit and Testing by Bidders*

- A. Bidder is required to visit the Site and conduct a thorough visual examination of the Site and adjacent areas. During the visit the Bidder must not disturb any ongoing operations at the Site.
- B. **OMITTED**
- C. **OMITTED**
- D. Bidders visiting the Site are required to arrange their own transportation to the Site.
- E. **OMITTED**
- F. Bidder is not required to conduct any subsurface testing, or exhaustive investigations of Site conditions.
- G. On request, and to the extent Owner has control over the Site, and schedule permitting, the Owner will provide Bidder general access to the Site to conduct such additional examinations, investigations, explorations, tests, and studies as Bidder deems necessary for preparing and submitting a successful Bid. Owner will not have any obligation to grant such access if doing so is not practical because of existing operations, security or safety concerns, or restraints on Owner's authority regarding the Site. Bidder is responsible for establishing access needed to reach specific selected test sites.
- H. Bidder must comply with all applicable Laws and Regulations regarding excavation and location of utilities, obtain all permits, and comply with all terms and conditions established by Owner or by property owners or other entities controlling the Site with respect to schedule, access, existing operations, security, liability insurance, and applicable safety programs.
- I. Bidder must fill all holes and clean up and restore the Site to its former condition upon completion of such explorations, investigations, tests, and studies.

5.05 *Owner's Safety Program*

- A. Site visits and work at the Site may be governed by an Owner safety program. If an Owner safety program exists, it will be noted in the Supplementary Conditions.

5.06 *Other Work at the Site*

- A. **OMITTED**

ARTICLE 6—BIDDER'S REPRESENTATIONS AND CERTIFICATIONS

6.01 *Express Representations and Certifications in Bid Form, Agreement*

- A. The Bid Form that each Bidder will submit contains express representations regarding the Bidder's examination of Project documentation, Site visit, and preparation of the Bid, and certifications regarding lack of collusion or fraud in connection with the Bid. Bidder should review these representations and certifications, and assure that Bidder can make the representations and certifications in good faith, before executing and submitting its Bid.
- B. If Bidder is awarded the Contract, Bidder (as Contractor) will make similar express representations and certifications when it executes the Agreement.

ARTICLE 7—INTERPRETATIONS AND ADDENDA

7.01 Owner on its own initiative may issue Addenda to clarify, correct, supplement, or change the Bidding Documents.

7.02 Bidder shall submit all questions about the meaning or intent of the Bidding Documents to Engineer in writing. Contact information and submittal procedures for such questions are as follows:

- A. Hussey Gay Bell
c/o: Trent Hodges
531 South Main Street, Suite 201
Greenville, SC 29601
803-799-0444
thodges@husseygaybell.com

7.03 Interpretations or clarifications considered necessary by Engineer in response to such questions will be issued by Addenda delivered to all registered plan holders. Questions received less than 7 days prior to the date for opening of Bids may not be answered.

7.04 Only responses set forth in an Addendum will be binding. Oral and other interpretations or clarifications will be without legal effect. Responses to questions are not part of the Contract Documents unless set forth in an Addendum that expressly modifies or supplements the Contract Documents.

ARTICLE 8—BID SECURITY

8.01 A Bid must be accompanied by Bid security made payable to Owner in an amount of [5%] percent of Bidder's maximum Bid price (determined by adding the base bid and all alternates) and in the

form of a Bid bond issued by a surety meeting the requirements of Paragraph 6.01 of the General Conditions. Such Bid bond will be issued in the form included in the Bidding Documents.

- 8.02 The Bid security of the apparent Successful Bidder will be retained until Owner awards the contract to such Bidder, and such Bidder has executed the Contract, furnished the required Contract security, and met the other conditions of the Notice of Award, whereupon the Bid security will be released. If the Successful Bidder fails to execute and deliver the Contract and furnish the required Contract security within 15 days after the Notice of Award, Owner may consider Bidder to be in default, annul the Notice of Award, and the Bid security of that Bidder will be forfeited, in whole in the case of a penal sum bid bond, and to the extent of Owner's damages in the case of a damages-form bond. Such forfeiture will be Owner's exclusive remedy if Bidder defaults.
- 8.03 The Bid security of other Bidders that Owner believes to have a reasonable chance of receiving the award may be retained by Owner until the earlier of 7 days after the Effective Date of the Contract or 61 days after the Bid opening, whereupon Bid security furnished by such Bidders will be released.
- 8.04 Bid security of other Bidders that Owner believes do not have a reasonable chance of receiving the award will be released within 7 days after the Bid opening.

ARTICLE 9—CONTRACT TIMES

- 9.01 **OMITTED**
- 9.02 **OMITTED**
- 9.03 Provisions for liquidated damages, if any, for failure to timely attain a Milestone, Substantial Completion, or completion of the Work in readiness for final payment, are set forth in the Agreement.

ARTICLE 10—SUBSTITUTE AND "OR EQUAL" ITEMS

- 10.01 **OMITTED**
- 10.02 The Contract for the Work, as awarded, will be on the basis of materials and equipment specified or described in the Bidding Documents, and those "or-equal" or substitute or materials and equipment subsequently approved by Engineer prior to the submittal of Bids and identified by Addendum. No item of material or equipment will be considered by Engineer as an "or-equal" or substitute unless written request for approval has been submitted by Bidder and has been received by Engineer within 10 days of the issuance of the Advertisement for Bids or invitation to Bidders. Each such request must comply with the requirements of Paragraphs 7.05 and 7.06 of the General Conditions, and the review of the request will be governed by the principles in those paragraphs. The burden of proof of the merit of the proposed item is upon Bidder. Engineer's decision of approval or disapproval of a proposed item will be final. If Engineer approves any such proposed item, such approval will be set forth in an Addendum issued to all registered Bidders. Bidders cannot rely upon approvals made in any other manner.
- 10.03 All prices that Bidder sets forth in its Bid will be based on the presumption that the Contractor will furnish the materials and equipment specified or described in the Bidding Documents, as

supplemented by Addenda. Any assumptions regarding the possibility of post-Bid approvals of “or-equal” or substitution requests are made at Bidder’s sole risk.

ARTICLE 11—SUBCONTRACTORS, SUPPLIERS, AND OTHERS

- 11.01 A Bidder must be prepared to retain specific Subcontractors and Suppliers for the performance of the Work if required to do so by the Bidding Documents or in the Specifications. If a prospective Bidder objects to retaining any such Subcontractor or Supplier and the concern is not relieved by an Addendum, then the prospective Bidder should refrain from submitting a Bid.
- 11.02 The apparent Successful Bidder, and any other Bidder so requested, must submit to Owner a list of the Subcontractors or Suppliers proposed for the following portions of the Work within five days after Bid opening:
- A. As requested by the Owner.
- 11.03 If requested by Owner, such list must be accompanied by an experience statement with pertinent information regarding similar projects and other evidence of qualification for each such Subcontractor or Supplier. **If Owner or Engineer, after due investigation has reasonable objection to any proposed Subcontractor, Supplier, individual or entity, Owner may, before the Notice of Award is given, request apparent Successful Bidder to submit an acceptable substitute, without an increase in Bid price.”**
- 11.04 If apparent Successful Bidder declines to make any such substitution, Owner may award the Contract to the next lowest Bidder that proposes to use acceptable Subcontractors and Suppliers. Declining to make requested substitutions will constitute grounds for forfeiture of the Bid security of any Bidder. Any Subcontractor or Supplier, so listed and against which Owner or Engineer makes no written objection prior to the giving of the Notice of Award will be deemed acceptable to Owner and Engineer subject to subsequent revocation of such acceptance as provided in Paragraph 7.07 of the General Conditions.

ARTICLE 12—PREPARATION OF BID

- 12.01 The Bid Form is included with the Bidding Documents.
- A. All blanks on the Bid Form must be completed in ink and the Bid Form signed in ink. Erasures or alterations must be initialed in ink by the person signing the Bid Form. The owner/engineer may allow for electronic submissions on a case by case basis through written request and permission. A Bid price must be indicated for each section, Bid item, alternate, adjustment unit price item, and unit price item listed therein.
- B. If the Bid Form expressly indicates that submitting pricing on a specific alternate item is optional, and Bidder elects to not furnish pricing for such optional alternate item, then Bidder may enter the words “No Bid” or “Not Applicable.”
- 12.02 If Bidder has obtained the Bidding Documents as Electronic Documents, then Bidder shall prepare its Bid on a paper copy of the Bid Form printed from the Electronic Documents version of the Bidding Documents. The printed copy of the Bid Form must be clearly legible, printed on 8½ inch by 11-inch paper and as closely identical in appearance to the Electronic Document version of the Bid Form as may be practical. The Owner reserves the right to accept Bid Forms which nominally vary in appearance from the original paper version of the Bid Form, providing that all required information and submittals are included with the Bid.

- 12.03 A Bid by a corporation must be executed in the corporate name by a corporate officer (whose title must appear under the signature), accompanied by evidence of authority to sign. The corporate address and state of incorporation must be shown. **The corporate seal must be affixed and attested by the corporate secretary or an assistant corporate secretary.**
- 12.04 A Bid by a partnership must be executed in the partnership name and signed by a partner (whose title must appear under the signature), accompanied by evidence of authority to sign. The official address of the partnership must be shown.
- 12.05 A Bid by a limited liability company must be executed in the name of the firm by a member or other authorized person and accompanied by evidence of authority to sign. The state of formation of the firm and the official address of the firm must be shown.
- 12.06 A Bid by an individual must show the Bidder's name and official address.
- 12.07 A Bid by a joint venture must be executed by an authorized representative of each joint venturer in the manner indicated on the Bid Form. The joint venture must have been formally established prior to submittal of a Bid, and the official address of the joint venture must be shown.
- 12.08 All names must be printed in ink below the signatures.
- 12.09 The Bid must contain an acknowledgment of receipt of all Addenda, the numbers of which must be filled in on the Bid Form.
- 12.10 Postal and e-mail addresses and telephone number for communications regarding the Bid must be shown.
- 12.11 The Bid must contain evidence of Bidder's authority to do business in the state where the Project is located, or Bidder must certify in writing that it will obtain such authority within the time for acceptance of Bids and attach such certification to the Bid.
- 12.12 If Bidder is required to be licensed to submit a Bid or perform the Work in the state where the Project is located, the Bid must contain evidence of Bidder's licensure, or Bidder must certify in writing that it will obtain such licensure within the time for acceptance of Bids and attach such certification to the Bid. Bidder's state contractor license number, if any, must also be shown on the Bid Form.

ARTICLE 13—BASIS OF BID

13.01 **OMITTED**

13.02 **OMITTED**

13.03 **OMITTED**

13.04 **OMITTED**

13.05 *Unit Price*

- A. Bidders must submit a Bid on a unit price basis for each item of Work listed in the unit price section of the Bid Form.
- B. The "Bid Price" (sometimes referred to as the extended price) for each unit price Bid item will be the product of the "Estimated Quantity", which Owner or its representative has set forth in the Bid Form, for the item and the corresponding "Bid Unit Price" offered by the Bidder. The total of all unit price Bid items will be the sum of these "Bid Prices"; such total

will be used by Owner for Bid comparison purposes. The final quantities and Contract Price will be determined in accordance with Paragraph 13.03 of the General Conditions.

- C. Discrepancies between the multiplication of units of Work and unit prices will be resolved in favor of the unit prices. Discrepancies between the indicated sum of any column of figures and the correct sum thereof will be resolved in favor of the correct sum.

13.06 **OMITTED**

13.07 **OMITTED**

ARTICLE 14—SUBMITTAL OF BID

14.01 **OMITTED**

14.02 A Bid must be received no later than the date and time prescribed and at the place indicated in the Advertisement or invitation to bid and must be enclosed in a plainly marked package with the Project title, and, if applicable, the designated portion of the Project for which the Bid is submitted, the name and address of Bidder, and must be accompanied by the Bid security and other required documents. If a Bid is sent by mail or other delivery system, the sealed envelope containing the Bid must be enclosed in a separate package plainly marked on the outside with the notation "BID ENCLOSED." A mailed Bid must be addressed to the location designated in the Advertisement.

14.03 Bids received after the date and time prescribed for the opening of bids, or not submitted at the correct location or in the designated manner, will not be accepted and will be returned to the Bidder unopened.

ARTICLE 15—MODIFICATION AND WITHDRAWAL OF BID

15.01 An unopened Bid may be withdrawn by an appropriate document duly executed in the same manner that a Bid must be executed and delivered to the place where Bids are to be submitted prior to the date and time for the opening of Bids. Upon receipt of such notice, the unopened Bid will be returned to the Bidder.

15.02 **OMITTED**

15.03 If within 24 hours after Bids are opened any Bidder files a duly signed written notice with Owner and promptly thereafter demonstrates to the reasonable satisfaction of Owner that there was a material and substantial mistake in the preparation of its Bid, the Bidder may withdraw its Bid,

and the Bid security will be returned. Thereafter, if the Work is rebid, the Bidder will be disqualified from further bidding on the Work.

ARTICLE 16—OPENING OF BIDS

16.01 **OMITTED**

16.02 **OMITTED**

ARTICLE 17—BIDS TO REMAIN SUBJECT TO ACCEPTANCE

17.01 All Bids will remain subject to acceptance for the period of time stated in the Bid Form, but Owner may, in its sole discretion, release any Bid and return the Bid security prior to the end of this period.

ARTICLE 18—EVALUATION OF BIDS AND AWARD OF CONTRACT

18.01 Owner reserves the right to reject any or all Bids, including without limitation, nonconforming, nonresponsive, unbalanced, or conditional Bids. Owner also reserves the right to waive all minor Bid informalities not involving price, time, or changes in the Work.

18.02 Owner will reject the Bid of any Bidder that Owner finds, after reasonable inquiry and evaluation, to not be responsible.

18.03 If Bidder purports to add terms or conditions to its Bid, takes exception to any provision of the Bidding Documents, or attempts to alter the contents of the Contract Documents for purposes of the Bid, whether in the Bid itself or in a separate communication to Owner or Engineer, then Owner will reject the Bid as nonresponsive.

18.04 If Owner awards the contract for the Work, such award will be to the responsible Bidder submitting the lowest responsive Bid.

18.05 *Evaluation of Bids*

A. In evaluating Bids, Owner will consider whether the Bids comply with the prescribed requirements, and such alternates, unit prices, and other data, as may be requested in the Bid Form or prior to the Notice of Award.

B. **The Owner, may, determine the evaluation of Base Bid and any listed alternates to the best interest of the Owner.**

C. **OMITTED**

D. For the determination of the apparent low Bidder when unit price bids are submitted, Bids will be compared on the basis of the total of the products of the estimated quantity of each item and unit price Bid for that item, together with any lump sum items.

E. **OMITTED**

F. **OMITTED**

18.06 In evaluating whether a Bidder is responsible, Owner will consider the qualifications of the Bidder and may consider the qualifications and experience of Subcontractors and Suppliers proposed for

those portions of the Work for which the identity of Subcontractors and Suppliers must be submitted as provided in the Bidding Documents.

- 18.07 Owner may conduct such investigations as Owner deems necessary to establish the responsibility, qualifications, and financial ability of Bidders and any proposed Subcontractors or Suppliers.

ARTICLE 19—BONDS AND INSURANCE

- 19.01 Article 6 of the General Conditions, as may be modified by the Supplementary Conditions, sets forth Owner's requirements as to performance and payment bonds, other required bonds (if any), and insurance. When the Successful Bidder delivers the executed Agreement to Owner, it must be accompanied by required bonds and insurance documentation.

- 19.02 Article 8, Bid Security, of these Instructions, addresses any requirements for providing bid bonds as part of the bidding process.

ARTICLE 20—SIGNING OF AGREEMENT

- 20.01 When Owner issues a Notice of Award to the Successful Bidder, it will be accompanied by the unexecuted counterparts of the Agreement along with the other Contract Documents as identified in the Agreement. Within 10 days thereafter, Successful Bidder must execute and deliver the required number of counterparts of the Agreement and any bonds and insurance documentation required to be delivered by the Contract Documents to Owner. Within 10 days thereafter, Owner will deliver one fully executed counterpart of the Agreement to Successful Bidder, together with printed and electronic copies of the Contract Documents as stated in Paragraph 2.02 of the General Conditions.

ARTICLE 21—SALES AND USE TAXES

- 21.01 **OMITTED**

This document has important legal consequences; consultation with an attorney is encouraged with respect to its use or modification. This document should be adapted to the particular circumstances of the contemplated Project and the controlling Laws and Regulations.

BID FORM FOR CONSTRUCTION CONTRACT

Prepared By



Endorsed By



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BID FORM FOR CONSTRUCTION CONTRACT

The terms used in this Bid with initial capital letters have the meanings stated in the Instructions to Bidders, the General Conditions, and the Supplementary Conditions.

ARTICLE 1—OWNER AND BIDDER

- 1.01 This Bid is submitted to: The City of Pikeville, 25 Municipal Drive, Pikeville, TN 37367.
- 1.02 The undersigned Bidder proposes and agrees, if this Bid is accepted, to enter into an Agreement with Owner in the form included in the Bidding Documents to perform all Work as specified or indicated in the Bidding Documents for the prices and within the times indicated in this Bid and in accordance with the other terms and conditions of the Bidding Documents.

ARTICLE 2—ATTACHMENTS TO THIS BID

- 2.01 The following documents are submitted with and made a condition of this Bid:
 - A. Required Bid security;
 - B. List of Proposed Subcontractors;
 - C. List of Proposed Suppliers;
 - D. Evidence of authority to do business in the state of the Project; or a written covenant to obtain such authority within the time for acceptance of Bids;
 - E. Contractor's license number as evidence of Bidder's State Contractor's License or a covenant by Bidder to obtain said license within the time for acceptance of Bids;
 - F. Required Bidder Qualification Statement with supporting data.

ARTICLE 3—BASIS OF BID—LUMP SUM BID AND UNIT PRICES

- 3.01 **OMITTED**
- 3.02 *Unit Price Bids*
 - A. Bidder will perform the following Work at the indicated unit prices:

Pikeville 0.366 MGD Wastewater Treatment Plant – Bid Form

Base Bid:

Item No.	Description	Unit	Estimated Quantity	Bid Unit Price	Bid Amount
1	Pikeville 0.366 MGD Wastewater Treatment Plant Including Ovivo-Supplied Aeration & Clarifier Equipment	1	LS	\$	\$
2	Allowance for Laboratory Desktop Equipment & Supplies	1	LS	\$75,000	\$75,000
3	Allowance for WWTP Plaque	1	LS	\$3,000	\$3,000
4	MR Systems Equipment Allowance - See Appendices for Scope	1	LS	\$382,388	\$382,388
Total Amount of Base Bid - Items 1, 2, 3, & 4 inclusive:					\$

Bid Alternate (Not Mandatory):

Item No.	Description	Unit	Estimated Quantity	Bid Unit Price	Bid Amount
1A.	Credit for Alternate Aeration Basin & Clarifier Including Re-Design of Structure & Installation	1	LS	\$	\$
Base Bid + Bid Alternate:					\$

B. Bidder acknowledges that:

- Each Bid Unit Price includes an amount considered by Bidder to be adequate to cover Contractor’s overhead and profit for each separately identified item, and
- Estimated quantities are not guaranteed and are solely for the purpose of comparison of Bids, and final payment for all Unit Price Work will be based on actual quantities, determined as provided in the Contract Documents.

3.03 *Total Bid Price – Base Bid (Lump Sum and Unit Prices)*

Total Bid Price – Base Bid (Total of all Lump Sum and Unit Price Bids)	\$
-------------------------------------------------------------------------------	----

3.04 *Total Bid Price – Alternate (Lump Sum and Unit Prices)*

Total Bid Price – Alternate (Total of all Lump Sum and Unit Price Bids)	\$
--------------------------------------------------------------------------------	----

ARTICLE 4—OMITTED

ARTICLE 5—TIME OF COMPLETION

- 5.01 Bidder agrees that the Work will be substantially complete and will be completed and ready for final payment in accordance with Paragraph 15.06 of the General Conditions on or before the dates or within the number of calendar days indicated in the Agreement.
- 5.02 Bidder agrees that the Work will be substantially complete on or before 730 days after the Notice to Proceed date and will be completed and ready for final payment in accordance with Paragraph 15.06 of the General Conditions on or before 730 days after the Notice To Proceed date.
- 5.03 Bidder agrees that the Work will be substantially complete within 730 days after the date when the Contract Times commence to run as provided in Paragraph 4.01 of the General Conditions and will be completed and ready for final payment in accordance with Paragraph 15.06 of the General Conditions within 730 days after the date when the Contract Times commence to run.
- 5.04 Bidder accepts the provisions of the Agreement as to liquidated damages.

ARTICLE 6—BIDDER’S ACKNOWLEDGEMENTS: ACCEPTANCE PERIOD, INSTRUCTIONS, AND RECEIPT OF ADDENDA

6.01 *Bid Acceptance Period*

- A. This Bid will remain subject to acceptance for 60 days after the Bid opening, or for such longer period of time that Bidder may agree to in writing upon request of Owner.

6.02 *Instructions to Bidders*

- A. Bidder accepts all of the terms and conditions of the Instructions to Bidders, including without limitation those dealing with the disposition of Bid security.

6.03 *Receipt of Addenda*

Bidder hereby acknowledges receipt of the following Addenda:

Addendum Number	Addendum Date

ARTICLE 7—BIDDER’S REPRESENTATIONS AND CERTIFICATIONS

7.01 *Bidder’s Representations*

- A. In submitting this Bid, Bidder represents the following:
 - 1. Bidder has examined and carefully studied the Bidding Documents, including Addenda.
 - 2. Bidder has visited the Site, conducted a thorough visual examination of the Site and adjacent areas, and become familiar with the general, local, and Site conditions that may affect cost, progress, and performance of the Work.
 - 3. Bidder is familiar with all Laws and Regulations that may affect cost, progress, and performance of the Work.
 - 4. Bidder has carefully studied the reports of explorations and tests of subsurface conditions at or adjacent to the Site and the drawings of physical conditions relating to existing surface or subsurface structures at the Site that have been identified in the Supplementary Conditions, with respect to the Technical Data in such reports and drawings.
 - 5. Bidder has carefully studied the reports and drawings relating to Hazardous Environmental Conditions, if any, at or adjacent to the Site that have been identified in the Supplementary Conditions, with respect to Technical Data in such reports and drawings.
 - 6. Bidder has considered the information known to Bidder itself; information commonly known to contractors doing business in the locality of the Site; information and observations obtained from visits to the Site; the Bidding Documents; and the Technical Data identified in the Supplementary Conditions or by definition, with respect to the effect of such information, observations, and Technical Data on (a) the cost, progress, and performance of the Work; (b) the means, methods, techniques, sequences, and procedures of construction to be employed by Bidder, if selected as Contractor; and (c) Bidder’s (Contractor’s) safety precautions and programs.
 - 7. Based on the information and observations referred to in the preceding paragraph, Bidder agrees that no further examinations, investigations, explorations, tests, studies, or data are necessary for the performance of the Work at the Contract Price, within the Contract Times, and in accordance with the other terms and conditions of the Contract.
 - 8. Bidder is aware of the general nature of work to be performed by Owner and others at the Site that relates to the Work as indicated in the Bidding Documents.
 - 9. Bidder has given Engineer written notice of all conflicts, errors, ambiguities, or discrepancies that Bidder has discovered in the Bidding Documents, and of discrepancies between Site conditions and the Contract Documents, and the written resolution thereof by Engineer is acceptable to Contractor.
 - 10. The Bidding Documents are generally sufficient to indicate and convey understanding of all terms and conditions for performance and furnishing of the Work.

11. The submission of this Bid constitutes an incontrovertible representation by Bidder that without exception the Bid and all prices in the Bid are premised upon performing and furnishing the Work required by the Bidding Documents.

7.02 *Bidder's Certifications*

A. The Bidder certifies the following:

1. This Bid is genuine and not made in the interest of or on behalf of any undisclosed individual or entity and is not submitted in conformity with any collusive agreement or rules of any group, association, organization, or corporation.
2. Bidder has not directly or indirectly induced or solicited any other Bidder to submit a false or sham Bid.
3. Bidder has not solicited or induced any individual or entity to refrain from bidding.
4. Bidder has not engaged in corrupt, fraudulent, collusive, or coercive practices in competing for the Contract. For the purposes of this Paragraph 8.02.A:
 - a. Corrupt practice means the offering, giving, receiving, or soliciting of anything of value likely to influence the action of a public official in the bidding process.
 - b. Fraudulent practice means an intentional misrepresentation of facts made (a) to influence the bidding process to the detriment of Owner, (b) to establish bid prices at artificial non-competitive levels, or (c) to deprive Owner of the benefits of free and open competition.
 - c. Collusive practice means a scheme or arrangement between two or more Bidders, with or without the knowledge of Owner, a purpose of which is to establish bid prices at artificial, non-competitive levels.
 - d. Coercive practice means harming or threatening to harm, directly or indirectly, persons or their property to influence their participation in the bidding process or affect the execution of the Contract.

BIDDER hereby submits this Bid as set forth above:

Bidder:

(typed or printed name of organization)

By: _____
(individual's signature)

Name: _____
(typed or printed)

Title: _____
(typed or printed)

Date: _____
(typed or printed)

If Bidder is a corporation, a partnership, or a joint venture, attach evidence of authority to sign.

Attest: _____
(individual's signature)

Name: _____
(typed or printed)

Title: _____
(typed or printed)

Date: _____
(typed or printed)

Address for giving notices:

Bidder's Contact:

Name: _____
(typed or printed)

Title: _____
(typed or printed)

Phone: _____

Email: _____

Address: _____

Bidder's Contractor License No.: (if applicable) _____

This document has important legal consequences; consultation with an attorney is encouraged with respect to its use or modification. This document should be adapted to the particular circumstances of the contemplated Project and the controlling Laws and Regulations.

BID BOND (DAMAGES FORM)

Prepared By



Endorsed By



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BID BOND (DAMAGES FORM)

Bidder Name: _____ Address (<i>principal place of business</i>): _____	Surety Name: _____ Address (<i>principal place of business</i>): _____
Owner Name: City of Pikeville Address (<i>principal place of business</i>): 25 Municipal Drive, Pikeville, TN 37367	Bid Project (<i>name and location</i>): Pikeville 0.366 MGD Wastewater Treatment Plant 25 Municipal Drive, Pikeville, TN 37367 Bid Due Date: June 26, 2024, 2:00 PM (Local)
Bond (5% of Bidders Maximum Bid Price) Refer to Section C-200 Article 8 – Bid Security Bond Amount: _____ Date of Bond: _____	
Surety and Bidder, intending to be legally bound hereby, subject to the terms set forth in this Bid Bond, do each cause this Bid Bond to be duly executed by an authorized officer, agent, or representative.	
Bidder _____ (<i>Full formal name of Bidder</i>)	Surety _____ (<i>Full formal name of Surety</i>) (<i>corporate seal</i>)
By: _____ (<i>Signature</i>)	By: _____ (<i>Signature</i>) (<i>Attach Power of Attorney</i>)
Name: _____ (<i>Printed or typed</i>)	Name: _____ (<i>Printed or typed</i>)
Title: _____	Title: _____
Attest: _____ (<i>Signature</i>)	Attest: _____ (<i>Signature</i>)
Name: _____ (<i>Printed or typed</i>)	Name: _____ (<i>Printed or typed</i>)
Title: _____	Title: _____
Notes: (1) Note: Addresses are to be used for giving any required notice. (2) Provide execution by any additional parties, such as joint venturers, if necessary.	

1. Bidder and Surety, jointly and severally, bind themselves, their heirs, executors, administrators, successors, and assigns to pay to Owner upon default of Bidder any difference between the total amount of Bidder's Bid and the total amount of the Bid of the next lowest, responsible Bidder that submitted a responsive Bid, as determined by Owner, for the work required by the Contract Documents, provided that:
 - 1.1. If there is no such next Bidder, and Owner does not abandon the Project, then Bidder and Surety shall pay to Owner the bond amount set forth on the face of this Bond, and
 - 1.2. In no event will Bidder's and Surety's obligation hereunder exceed the bond amount set forth on the face of this Bond.
 - 1.3. Recovery under the terms of this Bond will be Owner's sole and exclusive remedy upon default of Bidder.
2. Default of Bidder occurs upon the failure of Bidder to deliver within the time required by the Bidding Documents (or any extension thereof agreed to in writing by Owner) the executed Agreement required by the Bidding Documents and any performance and payment bonds required by the Bidding Documents.
3. This obligation will be null and void if:
 - 3.1. Owner accepts Bidder's Bid and Bidder delivers within the time required by the Bidding Documents (or any extension thereof agreed to in writing by Owner) the executed Agreement required by the Bidding Documents and any performance and payment bonds required by the Bidding Documents, or
 - 3.2. All Bids are rejected by Owner, or
 - 3.3. Owner fails to issue a Notice of Award to Bidder within the time specified in the Bidding Documents (or any extension thereof agreed to in writing by Bidder and, if applicable, consented to by Surety when required by Paragraph 5 hereof).
4. Payment under this Bond will be due and payable upon default of Bidder and within 30 calendar days after receipt by Bidder and Surety of written notice of default from Owner, which notice will be given with reasonable promptness, identifying this Bond and the Project and including a statement of the amount due.
5. Surety waives notice of any and all defenses based on or arising out of any time extension to issue Notice of Award agreed to in writing by Owner and Bidder, provided that the total time for issuing Notice of Award including extensions will not in the aggregate exceed 120 days from Bid due date without Surety's written consent.
6. No suit or action will be commenced under this Bond prior to 30 calendar days after the notice of default required in Paragraph 4 above is received by Bidder and Surety, and in no case later than one year after the Bid due date.
7. Any suit or action under this Bond must be commenced only in a court of competent jurisdiction located in the state in which the Project is located.
8. Notices required hereunder must be in writing and sent to Bidder and Surety at their respective addresses shown on the face of this Bond. Such notices may be sent by personal delivery, commercial courier, or by United States Postal Service registered or certified mail, return receipt requested, postage pre-paid, and will be deemed to be effective upon receipt by the party concerned.
9. Surety shall cause to be attached to this Bond a current and effective Power of Attorney evidencing the authority of the officer, agent, or representative who executed this Bond on behalf of Surety to execute, seal, and deliver such Bond and bind the Surety thereby.
10. This Bond is intended to conform to all applicable statutory requirements. Any applicable requirement of any applicable statute that has been omitted from this Bond will be deemed to be included herein as if set forth at length. If any provision of this Bond conflicts with any applicable statute, then the provision of said statute governs and the remainder of this Bond that is not in conflict therewith continues in full force and effect.
11. The term "Bid" as used herein includes a Bid, offer, or proposal as applicable.

This document has important legal consequences; consultation with an attorney is encouraged with respect to its use or modification. This document should be adapted to the particular circumstances of the contemplated Project and the controlling Laws and Regulations.

QUALIFICATIONS STATEMENT

Prepared By



Endorsed By



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ARTICLE 1—GENERAL INFORMATION

1.01 Provide contact information for the Business:

Legal Name of Business:			
Corporate Office			
Name:		Phone number:	
Title:		Email address:	
Business address of corporate office:			
Local Office			
Name:		Phone number:	
Title:		Email address:	
Business address of local office:			

1.02 Provide information on the Business’s organizational structure:

Form of Business:	<input type="checkbox"/> Sole Proprietorship <input type="checkbox"/> Partnership <input type="checkbox"/> Corporation		
	<input type="checkbox"/> Limited Liability Company <input type="checkbox"/> Joint Venture comprised of the following companies:		
	1.		
	2.		
	3.		
Provide a separate Qualification Statement for each Joint Venturer.			
Date Business was formed:		State in which Business was formed:	
Is this Business authorized to operate in the Project location?		<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Pending	

1.03 Identify all businesses that own Business in whole or in part (25% or greater), or that are wholly or partly (25% or greater) owned by Business:

Name of business:		Affiliation:	
Address:			
Name of business:		Affiliation:	
Address:			
Name of business:		Affiliation:	
Address:			

1.04 Provide information regarding the Business’s officers, partners, and limits of authority.

Name:		Title:	
Authorized to sign contracts:	<input type="checkbox"/> Yes <input type="checkbox"/> No	Limit of Authority:	\$
Name:		Title:	
Authorized to sign contracts:	<input type="checkbox"/> Yes <input type="checkbox"/> No	Limit of Authority:	\$
Name:		Title:	
Authorized to sign contracts:	<input type="checkbox"/> Yes <input type="checkbox"/> No	Limit of Authority:	\$
Name:		Title:	

ARTICLE 2—LICENSING

2.01 Provide information regarding licensure for Business:

Name of License:			
Licensing Agency:			
License No:		Expiration Date:	
Name of License:			
Licensing Agency:			
License No:		Expiration Date:	

ARTICLE 3—DIVERSE BUSINESS CERTIFICATIONS

3.01 Provide information regarding Business’s Diverse Business Certification, if any. Provide evidence of current certification.

Certification	Certifying Agency	Certification Date
<input type="checkbox"/> Disadvantaged Business Enterprise		
<input type="checkbox"/> Minority Business Enterprise		
<input type="checkbox"/> Woman-Owned Business Enterprise		
<input type="checkbox"/> Small Business Enterprise		
<input type="checkbox"/> Disabled Business Enterprise		
<input type="checkbox"/> Veteran-Owned Business Enterprise		
<input type="checkbox"/> Service-Disabled Veteran-Owned Business		
<input type="checkbox"/> HUBZone Business (Historically Underutilized) Business		
<input type="checkbox"/> Other		
<input type="checkbox"/> None		

ARTICLE 4—SAFETY

4.01 Provide information regarding Business’s safety organization and safety performance.

Name of Business’s Safety Officer:		
Safety Certifications		
Certification Name	Issuing Agency	Expiration

4.02 Provide Worker’s Compensation Insurance Experience Modification Rate (EMR), Total Recordable Frequency Rate (TRFR) for incidents, and Total Number of Recorded Manhours (MH) for the last 3 years and the EMR, TRFR, and MH history for the last 3 years of any proposed Subcontractor(s) that will provide Work valued at 10% or more of the Contract Price. Provide documentation of the EMR history for Business and Subcontractor(s).

Year									
Company	EMR	TRFR	MH	EMR	TRFR	MH	EMR	TRFR	MH

ARTICLE 5—FINANCIAL

5.01 Provide information regarding the Business’s financial stability. Provide the most recent audited financial statement, and if such audited financial statement is not current, also provide the most current financial statement.

Financial Institution:		
Business address:		
Date of Business’s most recent financial statement:		<input type="checkbox"/> Attached
Date of Business’s most recent audited financial statement:		<input type="checkbox"/> Attached
Financial indicators from the most recent financial statement		
Contractor’s Current Ratio (Current Assets ÷ Current Liabilities)		
Contractor’s Quick Ratio ((Cash and Cash Equivalents + Accounts Receivable + Short Term Investments) ÷ Current Liabilities)		

ARTICLE 6—SURETY INFORMATION

6.01 Provide information regarding the surety company that will issue required bonds on behalf of the Business, including but not limited to performance and payment bonds.

Surety Name:			
Surety is a corporation organized and existing under the laws of the state of:			
Is surety authorized to provide surety bonds in the Project location?	<input type="checkbox"/> Yes <input type="checkbox"/> No		
Is surety listed in “Companies Holding Certificates of Authority as Acceptable Sureties on Federal Bonds and as Acceptable Reinsuring Companies” published in Department Circular 570 (as amended) by the Bureau of the Fiscal Service, U.S. Department of the Treasury? <input type="checkbox"/> Yes <input type="checkbox"/> No			
Mailing Address (principal place of business):			
Physical Address (principal place of business):			
Phone (main):		Phone (claims):	

ARTICLE 7—INSURANCE

7.01 Provide information regarding Business’s insurance company(s), including but not limited to its Commercial General Liability carrier. Provide information for each provider.

Name of insurance provider, and type of policy (CLE, auto, etc.):			
Insurance Provider		Type of Policy (Coverage Provided)	
Are providers licensed or authorized to issue policies in the Project location?			<input type="checkbox"/> Yes <input type="checkbox"/> No
Does provider have an A.M. Best Rating of A-VII or better?			<input type="checkbox"/> Yes <input type="checkbox"/> No
Mailing Address (principal place of business):			
Physical Address (principal place of business):			
Phone (main):		Phone (claims):	

ARTICLE 8—CONSTRUCTION EXPERIENCE

8.01 Provide information that will identify the overall size and capacity of the Business.

Average number of current full-time employees:	
Estimate of revenue for the current year:	
Estimate of revenue for the previous year:	

8.02 Provide information regarding the Business’s previous contracting experience.

Years of experience with projects like the proposed project:		
As a general contractor:		As a joint venturer:
Has Business, or a predecessor in interest, or an affiliate identified in Paragraph 1.03:		
Been disqualified as a bidder by any local, state, or federal agency within the last 5 years? <input type="checkbox"/> Yes <input type="checkbox"/> No		
Been barred from contracting by any local, state, or federal agency within the last 5 years? <input type="checkbox"/> Yes <input type="checkbox"/> No		
Been released from a bid in the past 5 years? <input type="checkbox"/> Yes <input type="checkbox"/> No		
Defaulted on a project or failed to complete any contract awarded to it? <input type="checkbox"/> Yes <input type="checkbox"/> No		
Refused to construct or refused to provide materials defined in the contract documents or in a change order? <input type="checkbox"/> Yes <input type="checkbox"/> No		
Been a party to any currently pending litigation or arbitration? <input type="checkbox"/> Yes <input type="checkbox"/> No		
Provide full details in a separate attachment if the response to any of these questions is Yes.		

8.03 List all projects currently under contract in Schedule A and provide indicated information.

8.04 List a minimum of three and a maximum of six projects completed in the last 5 years in Schedule B and provide indicated information to demonstrate the Business’s experience with projects similar in type and cost of construction.

8.05 In Schedule C, provide information on key individuals whom Business intends to assign to the Project. Provide resumes for those individuals included in Schedule C. Key individuals include the Project Manager, Project Superintendent, Quality Manager, and Safety Manager. Resumes may be provided for Business’s key leaders as well.

ARTICLE 9—REQUIRED ATTACHMENTS

9.01 Provide the following information with the Statement of Qualifications:

- A. If Business is a Joint Venture, separate Qualifications Statements for each Joint Venturer, as required in Paragraph 1.02.
- B. Diverse Business Certifications if required by Paragraph 3.01.
- C. Certification of Business’s safety performance if required by Paragraph 4.02.
- D. Financial statements as required by Paragraph 5.01.

- E. Attachments providing additional information as required by Paragraph 8.02.
- F. Schedule A (Current Projects) as required by Paragraph 8.03.
- G. Schedule B (Previous Experience with Similar Projects) as required by Paragraph 8.04.
- H. Schedule C (Key Individuals) and resumes for the key individuals listed, as required by Paragraph 8.05.
- I. Additional items as pertinent.

This Statement of Qualifications is offered by:

Business: _____
(typed or printed name of organization)

By: _____
(individual's signature)

Name: _____
(typed or printed)

Title: _____
(typed or printed)

Date: _____
(date signed)

(If Business is a corporation, a partnership, or a joint venture, attach evidence of authority to sign.)

Attest: _____
(individual's signature)

Name: _____
(typed or printed)

Title: _____
(typed or printed)

Address for giving notices:

Designated Representative:

Name: _____
(typed or printed)

Title: _____
(typed or printed)

Address: _____

Phone: _____

Email: _____

Schedule A—Current Projects

Name of Organization					
Project Owner			Project Name		
General Description of Project					
Project Cost			Date Project		
Key Project Personnel	Project Manager	Project Superintendent	Safety Manager	Quality Control Manager	
Name					
Reference Contact Information (listing names indicates approval to contacting the names individuals as a reference)					
	Name	Title/Position	Organization	Telephone	Email
Owner					
Designer					
Construction Manager					
<hr/>					
Project Owner			Project Name		
General Description of Project					
Project Cost			Date Project		
Key Project Personnel	Project Manager	Project Superintendent	Safety Manager	Quality Control Manager	
Name					
Reference Contact Information (listing names indicates approval to contacting the names individuals as a reference)					
	Name	Title/Position	Organization	Telephone	Email
Owner					
Designer					
Construction Manager					
<hr/>					
Project Owner			Project Name		
General Description of Project					
Project Cost			Date Project		
Key Project Personnel	Project Manager	Project Superintendent	Safety Manager	Quality Control Manager	
Name					
Reference Contact Information (listing names indicates approval to contacting the names individuals as a reference)					
	Name	Title/Position	Organization	Telephone	Email
Owner					
Designer					
Construction Manager					

Schedule B—Previous Experience with Similar Projects

Name of Organization					
Project Owner			Project Name		
General Description of Project					
Project Cost			Date Project		
Key Project Personnel	Project Manager	Project Superintendent	Safety Manager	Quality Control Manager	
Name					
Reference Contact Information (listing names indicates approval to contacting the names individuals as a reference)					
	Name	Title/Position	Organization	Telephone	Email
Owner					
Designer					
Construction Manager					

Project Owner			Project Name		
General Description of Project					
Project Cost			Date Project		
Key Project Personnel	Project Manager	Project Superintendent	Safety Manager	Quality Control Manager	
Name					
Reference Contact Information (listing names indicates approval to contacting the names individuals as a reference)					
	Name	Title/Position	Organization	Telephone	Email
Owner					
Designer					
Construction Manager					

Project Owner			Project Name		
General Description of Project					
Project Cost			Date Project		
Key Project Personnel	Project Manager	Project Superintendent	Safety Manager	Quality Control Manager	
Name					
Reference Contact Information (listing names indicates approval to contacting the names individuals as a reference)					
	Name	Title/Position	Organization	Telephone	Email
Owner					
Designer					
Construction Manager					

Schedule B—Previous Experience with Similar Projects

Name of Organization					
Project Owner			Project Name		
General Description of Project					
Project Cost			Date Project		
Key Project Personnel	Project Manager	Project Superintendent	Safety Manager	Quality Control Manager	
Name					
Reference Contact Information (listing names indicates approval to contacting the names individuals as a reference)					
	Name	Title/Position	Organization	Telephone	Email
Owner					
Designer					
Construction Manager					

Project Owner			Project Name		
General Description of Project					
Project Cost			Date Project		
Key Project Personnel	Project Manager	Project Superintendent	Safety Manager	Quality Control Manager	
Name					
Reference Contact Information (listing names indicates approval to contacting the names individuals as a reference)					
	Name	Title/Position	Organization	Telephone	Email
Owner					
Designer					
Construction Manager					

Project Owner			Project Name		
General Description of Project					
Project Cost			Date Project		
Key Project Personnel	Project Manager	Project Superintendent	Safety Manager	Quality Control Manager	
Name					
Reference Contact Information (listing names indicates approval to contacting the names individuals as a reference)					
	Name	Title/Position	Organization	Telephone	Email
Owner					
Designer					
Construction Manager					

Schedule C—Key Individuals

Project Manager			
Name of individual			
Years of experience as project manager			
Years of experience with this organization			
Number of similar projects as project manager			
Number of similar projects in other positions			
Current Project Assignments			
Name of assignment		Percent of time used for this project	Estimated project completion date
Reference Contact Information (listing names indicates approval to contact named individuals as a reference)			
Name		Name	
Title/Position		Title/Position	
Organization		Organization	
Telephone		Telephone	
Email		Email	
Project		Project	
Candidate's role on project		Candidate's role on project	
Project Superintendent			
Name of individual			
Years of experience as project superintendent			
Years of experience with this organization			
Number of similar projects as project superintendent			
Number of similar projects in other positions			
Current Project Assignments			
Name of assignment		Percent of time used for this project	Estimated project completion date
Reference Contact Information (listing names indicates approval to contact named individuals as a reference)			
Name		Name	
Title/Position		Title/Position	
Organization		Organization	
Telephone		Telephone	
Email		Email	
Project		Project	
Candidate's role on project		Candidate's role on project	

Safety Manager			
Name of individual			
Years of experience as project manager			
Years of experience with this organization			
Number of similar projects as project manager			
Number of similar projects in other positions			
Current Project Assignments			
Name of assignment		Percent of time used for this project	Estimated project completion date
Reference Contact Information (listing names indicates approval to contact named individuals as a reference)			
Name		Name	
Title/Position		Title/Position	
Organization		Organization	
Telephone		Telephone	
Email		Email	
Project		Project	
Candidate's role on project		Candidate's role on project	
Quality Control Manager			
Name of individual			
Years of experience as project superintendent			
Years of experience with this organization			
Number of similar projects as project superintendent			
Number of similar projects in other positions			
Current Project Assignments			
Name of assignment		Percent of time used for this project	Estimated project completion date
Reference Contact Information (listing names indicates approval to contact named individuals as a reference)			
Name		Name	
Title/Position		Title/Position	
Organization		Organization	
Telephone		Telephone	
Email		Email	
Project		Project	
Candidate's role on project		Candidate's role on project	

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NOTICE OF AWARD

Prepared By



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NOTICE OF AWARD

Date of Issuance:

Owner: City of Pikeville

Owner's Project No.:

Engineer: Hussey Gay Bell

Engineer's Project No.: 120300101

Project: Pikeville 0.366 MGD Wastewater Treatment Plant

Contract Name: Pikeville 0.366 MGD Wastewater Treatment Plant

Bidder:

Bidder's Address:

You are notified that Owner has accepted your Bid dated **(DATE)**, for the above Contract, and that you are the Successful Bidder and are awarded a Contract for:

Pikeville 0.366 MGD Wastewater Treatment Plant

The Contract Price of the awarded Contract is \$_____ Contract Price is subject to adjustment based on the provisions of the Contract, including but not limited to those governing changes, Unit Price Work, and Work performed on a cost-plus-fee basis, as applicable.

Four (4) unexecuted counterparts of the Agreement accompany this Notice of Award, and one copy of the Contract Documents accompanies this Notice of Award, or has been transmitted or made available to Bidder electronically.

Drawings will be delivered separately from the other Contract Documents.

You must comply with the following conditions precedent within 10 days of the date of receipt of this Notice of Award:

1. Deliver to Owner Four (4) counterparts of the Agreement, signed by Bidder (as Contractor).
2. Deliver with the signed Agreement(s) the Contract security (such as required performance and payment bonds) and insurance documentation, as specified in the Instructions to Bidders and in the General Conditions, Articles 2 and 6.
3. Other conditions precedent (if any):

Failure to comply with these conditions within the time specified will entitle Owner to consider you in default, annul this Notice of Award, and declare your Bid security forfeited.

Within 10 days after you comply with the above conditions, Owner will return to you one fully signed counterpart of the Agreement, together with any additional copies of the Contract Documents as indicated in Paragraph 2.02 of the General Conditions.

Owner: City of Pikeville

By (signature): _____

Name (printed): _____

Title: _____

Copy: Engineer

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AGREEMENT BETWEEN OWNER AND CONTRACTOR FOR CONSTRUCTION CONTRACT (STIPULATED PRICE)

Prepared By



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AGREEMENT BETWEEN OWNER AND CONTRACTOR FOR CONSTRUCTION CONTRACT (STIPULATED PRICE)

This Agreement is by and between City of Pikeville and _____ (“Contractor”).

Terms used in this Agreement have the meanings stated in the General Conditions and the Supplementary Conditions.

Owner and Contractor hereby agree as follows:

ARTICLE 1—WORK

1.01 Contractor shall complete all Work as specified or indicated in the Contract Documents. The Work is generally described as follows:

Depending on the project type, description should include but not limited to:

- Linear feet, diameter, and type of force main, gravity sewer or low-pressure sewer
- Proposed treatment process
- Treatment/storage/pumping capacity
- For line rehabilitation, include: linear feet and size by activity, e.g, replacement, pipe-bursting, cured-in-place, slip-line, TV inspection, smoke testing; number of man hole or service lateral rehabs.

ARTICLE 2—THE PROJECT

2.01 The Project, of which the Work under the Contract Documents is a part, is generally described as follows: The Construction of a new 0.366 MGD Wastewater Treatment Plant including mechanical and manual influent screens, bypass piping, Parshall flumes, aeration basin & equipment, clarifiers & equipment, chlorination/dechlorination equipment and basin, plant drain pump station, RAS/WAS pump station, sludge digester, sludge belt press & building, electrical, SCADA, process piping, lab/office/control & MCC buildings, site work, and associated appurtenances.

ARTICLE 3—ENGINEER

3.01 The Owner has retained Hussey, Gay Bell & DeYoung, Inc hereinafter referred to as Hussey Gay Bell (“Engineer”) to act as Owner’s representative, assume all duties and responsibilities of Engineer, and have the rights and authority assigned to Engineer in the Contract.

3.02 The part of the Project that pertains to the Work has been designed by Hussey Gay Bell.

ARTICLE 4—CONTRACT TIMES

4.01 *Time is of the Essence*

- A. All time limits for Milestones, if any, Substantial Completion, and completion and readiness for final payment as stated in the Contract Documents are of the essence of the Contract.

4.02 *Contract Times: Dates*

- A. The Work will be substantially complete 730 days after the Notice to Proceeds is issued and completed and ready for final payment in accordance with Paragraph 15.06 of the General Conditions.

4.03 *Contract Times: Days*

- A. The Work will be substantially complete within 730 days after the date when the Contract Times commence to run as provided in Paragraph 4.01 of the General Conditions, and completed and ready for final payment in accordance with Paragraph 15.06 of the General Conditions within 730 days after the date when the Contract Times commence to run.

4.04 **OMITTED**

4.05 *Liquidated Damages*

- A. Contractor and Owner recognize that time is of the essence as stated in Paragraph 4.01 above and that Owner will suffer financial and other losses if the Work is not completed and Milestones not achieved within the Contract Times, as duly modified. The parties also recognize the delays, expense, and difficulties involved in proving, in a legal or arbitration proceeding, the actual loss suffered by Owner if the Work is not completed on time. Accordingly, instead of requiring any such proof, Owner and Contractor agree that as liquidated damages for delay (but not as a penalty):
 - 1. *Substantial Completion*: Contractor shall pay Owner \$500.00 for each day that expires after the time (as duly adjusted pursuant to the Contract) specified above for Substantial Completion, until the Work is substantially complete.
 - 2. *Completion of Remaining Work*: After Substantial Completion, if Contractor shall neglect, refuse, or fail to complete the remaining Work within the Contract Times (as duly adjusted pursuant to the Contract) for completion and readiness for final payment, Contractor shall pay Owner \$500.00 for each day that expires after such time until the Work is completed and ready for final payment.
 - 3. **OMITTED**
 - 4. Liquidated damages for failing to timely attain Milestones, Substantial Completion, and final completion are not additive, and will not be imposed concurrently.
- B. If Owner recovers liquidated damages for a delay in completion by Contractor, then such liquidated damages are Owner's sole and exclusive remedy for such delay, and Owner is precluded from recovering any other damages, whether actual, direct, excess, or consequential, for such delay, except for special damages (if any) specified in this Agreement.
- C. *Bonus*: **OMMITED**.

4.06 *Special Damages*

- A. Contractor shall reimburse Owner (1) for any fines or penalties imposed on Owner as a direct result of the Contractor's failure to attain Substantial Completion according to the Contract Times, and (2) for the actual costs reasonably incurred by Owner for engineering, construction observation, inspection, and administrative services needed after the time specified in

Paragraph 4.02 for Substantial Completion (as duly adjusted pursuant to the Contract), until the Work is substantially complete.

- B. After Contractor achieves Substantial Completion, if Contractor shall neglect, refuse, or fail to complete the remaining Work within the Contract Times, Contractor shall reimburse Owner for the actual costs reasonably incurred by Owner for engineering, construction observation, inspection, and administrative services needed after the time specified in Paragraph 4.02 for Work to be completed and ready for final payment (as duly adjusted pursuant to the Contract), until the Work is completed and ready for final payment.
- C. The special damages imposed in this paragraph are supplemental to any liquidated damages for delayed completion established in this Agreement.

ARTICLE 5—CONTRACT PRICE

5.01 Owner shall pay Contractor for completion of the Work in accordance with the Contract Documents, the amounts that follow, subject to adjustment under the Contract:

- A. For all Work other than Unit Price Work, a lump sum of \$_____.

All specific cash allowances are included in the above price in accordance with Paragraph 13.02 of the General Conditions.

- B. For all Unit Price Work, an amount equal to the sum of the extended prices (established for each separately identified item of Unit Price Work by multiplying the unit price times the actual quantity of that item).

Unit Price Work					
Item No.	Description	Estimated Quantity	Unit	Unit Price	Extended Price
				\$	\$
				\$	\$
				\$	\$
				\$	\$
				\$	\$
Total of all Extended Prices for Unit Price Work (subject to final adjustment based on actual quantities)					\$

The extended prices for Unit Price Work set forth as of the Effective Date of the Contract are based on estimated quantities. As provided in Paragraph 13.03 of the General Conditions, estimated quantities are not guaranteed, and determinations of actual quantities and classifications are to be made by Engineer.

- C. Total of Lump Sum Amount and Unit Price Work (subject to final Unit Price adjustment) \$_____.
- D. For all Work, at the prices stated in Contractor’s Bid, attached hereto as an exhibit.

ARTICLE 6—PAYMENT PROCEDURES

6.01 *Submittal and Processing of Payments*

- A. Contractor shall submit Applications for Payment in accordance with Article 15 of the General Conditions. Applications for Payment will be processed by Engineer as provided in the General Conditions.

6.02 *Progress Payments; Retainage*

- A. Owner shall make progress payments on the basis of Contractor's Applications for Payment on or about the 25th day of each month during performance of the Work as provided in Paragraph 6.02.A.1 below, provided that such Applications for Payment have been submitted in a timely manner and otherwise meet the requirements of the Contract. All such payments will be measured by the Schedule of Values established as provided in the General Conditions (and in the case of Unit Price Work based on the number of units completed) or, in the event there is no Schedule of Values, as provided elsewhere in the Contract.
 - 1. Prior to Substantial Completion, progress payments will be made in an amount equal to the percentage indicated below but, in each case, less the aggregate of payments previously made and less such amounts as Owner may withhold, including but not limited to liquidated damages, in accordance with the Contract.
 - a. 10% percent of the value of the Work completed (with the balance being retainage).
 - 1) If 50 percent or more of the Work has been completed, as determined by Engineer, and if the character and progress of the Work have been satisfactory to Owner and Engineer, then as long as the character and progress of the Work remain satisfactory to Owner and Engineer, there will be no additional retainage; and
 - b. 10% percent of cost of materials and equipment not incorporated in the Work (with the balance being retainage).
- B. Upon Substantial Completion, Owner shall pay an amount sufficient to increase total payments to Contractor to 0% percent of the Work completed, less such amounts set off by Owner pursuant to Paragraph 15.01.E of the General Conditions, and less 200% percent of Engineer's estimate of the value of Work to be completed or corrected as shown on the punch list of items to be completed or corrected prior to final payment.

6.03 *Final Payment*

- A. Upon final completion and acceptance of the Work, Owner shall pay the remainder of the Contract Price in accordance with Paragraph 15.06 of the General Conditions.

6.04 *Consent of Surety*

- A. Owner will not make final payment, or return or release retainage at Substantial Completion or any other time, unless Contractor submits written consent of the surety to such payment, return, or release.

6.05 *Interest*

- A. All amounts not paid when due will bear interest at the rate of 0% percent per annum.

ARTICLE 7—CONTRACT DOCUMENTS

7.01 *Contents*

- A. The Contract Documents consist of all of the following:
 1. This Agreement.
 2. Bonds:
 - a. Performance bond (together with power of attorney).
 - b. Payment bond (together with power of attorney).
 3. General Conditions.
 4. Supplementary Conditions.
 5. Specifications as listed in the table of contents of the project manual.
 6. Drawings (not attached but incorporated by reference) consisting of 145 sheets with each sheet bearing the following general title: **Pikeville 0.366 MGD Wastewater Treatment Plant**
 7. Drawings listed on the attached sheet index.
 8. Issued Addendums.
 9. Exhibits to this Agreement
 10. The following which may be delivered or issued on or after the Effective Date of the Contract and are not attached hereto:
 - a. Notice to Proceed.
 - b. Work Change Directives.
 - c. Change Orders.
 - d. Field Orders.
 - e. Warranty Bond, if any.
- B. The Contract Documents listed in Paragraph 7.01.A are attached to this Agreement (except as expressly noted otherwise above).
- C. There are no Contract Documents other than those listed above in this Article 7.
- D. The Contract Documents may only be amended, modified, or supplemented as provided in the Contract.

ARTICLE 8—REPRESENTATIONS, CERTIFICATIONS, AND STIPULATIONS

8.01 *Contractor's Representations*

- A. In order to induce Owner to enter into this Contract, Contractor makes the following representations:
 1. Contractor has examined and carefully studied the Contract Documents, including Addenda.

2. Contractor has visited the Site, conducted a thorough visual examination of the Site and adjacent areas, and become familiar with the general, local, and Site conditions that may affect cost, progress, and performance of the Work.
3. Contractor is familiar with all Laws and Regulations that may affect cost, progress, and performance of the Work.
4. Contractor has carefully studied the reports of explorations and tests of subsurface conditions at or adjacent to the Site and the drawings of physical conditions relating to existing surface or subsurface structures at the Site that have been identified in the Supplementary Conditions, with respect to the Technical Data in such reports and drawings.
5. Contractor has carefully studied the reports and drawings relating to Hazardous Environmental Conditions, if any, at or adjacent to the Site that have been identified in the Supplementary Conditions, with respect to Technical Data in such reports and drawings.
6. Contractor has considered the information known to Contractor itself; information commonly known to contractors doing business in the locality of the Site; information and observations obtained from visits to the Site; the Contract Documents; and the Technical Data identified in the Supplementary Conditions or by definition, with respect to the effect of such information, observations, and Technical Data on (a) the cost, progress, and performance of the Work; (b) the means, methods, techniques, sequences, and procedures of construction to be employed by Contractor; and (c) Contractor's safety precautions and programs.
7. Based on the information and observations referred to in the preceding paragraph, Contractor agrees that no further examinations, investigations, explorations, tests, studies, or data are necessary for the performance of the Work at the Contract Price, within the Contract Times, and in accordance with the other terms and conditions of the Contract.
8. Contractor is aware of the general nature of work to be performed by Owner and others at the Site that relates to the Work as indicated in the Contract Documents.
9. Contractor has given Engineer written notice of all conflicts, errors, ambiguities, or discrepancies that Contractor has discovered in the Contract Documents, and of discrepancies between Site conditions and the Contract Documents, and the written resolution thereof by Engineer is acceptable to Contractor.
10. The Contract Documents are generally sufficient to indicate and convey understanding of all terms and conditions for performance and furnishing of the Work.
11. Contractor's entry into this Contract constitutes an incontrovertible representation by Contractor that without exception all prices in the Agreement are premised upon performing and furnishing the Work required by the Contract Documents.

8.02 *Contractor's Certifications*

- A. Contractor certifies that it has not engaged in corrupt, fraudulent, collusive, or coercive practices in competing for or in executing the Contract. For the purposes of this Paragraph 8.02:

1. “corrupt practice” means the offering, giving, receiving, or soliciting of anything of value likely to influence the action of a public official in the bidding process or in the Contract execution;
2. “fraudulent practice” means an intentional misrepresentation of facts made (a) to influence the bidding process or the execution of the Contract to the detriment of Owner, (b) to establish Bid or Contract prices at artificial non-competitive levels, or (c) to deprive Owner of the benefits of free and open competition;
3. “collusive practice” means a scheme or arrangement between two or more Bidders, with or without the knowledge of Owner, a purpose of which is to establish Bid prices at artificial, non-competitive levels; and
4. “coercive practice” means harming or threatening to harm, directly or indirectly, persons or their property to influence their participation in the bidding process or affect the execution of the Contract.

8.03 *Standard General Conditions*

- A. Owner stipulates that if the General Conditions that are made a part of this Contract are EJCDC® C-700, Standard General Conditions for the Construction Contract (2018), published by the Engineers Joint Contract Documents Committee, and if Owner is the party that has furnished said General Conditions, then Owner has plainly shown all modifications to the standard wording of such published document to the Contractor, through a process such as highlighting or “track changes” (redline/strikeout), or in the Supplementary Conditions.

IN WITNESS WHEREOF, Owner and Contractor have signed this Agreement.

This Agreement will be effective on _____ (which is the Effective Date of the Contract).

Owner:

Contractor:

(typed or printed name of organization)

(typed or printed name of organization)

By: _____
(individual's signature)

By: _____
(individual's signature)

Date: _____
(date signed)

Date: _____
(date signed)

Name: _____
(typed or printed)

Name: _____
(typed or printed)

Title: _____
(typed or printed)

Title: _____
(typed or printed)

(If [Type of Entity] is a corporation, a partnership, or a joint venture, attach evidence of authority to sign.)

Attest: _____
(individual's signature)

Attest: _____
(individual's signature)

Title: _____
(typed or printed)

Title: _____
(typed or printed)

Address for giving notices:

Address for giving notices:

Designated Representative:

Designated Representative:

Name: _____
(typed or printed)

Name: _____
(typed or printed)

Title: _____
(typed or printed)

Title: _____
(typed or printed)

Address:

Address:

Phone: _____

Phone: _____

Email: _____

Email: _____

(If [Type of Entity] is a corporation, attach evidence of authority to sign. If [Type of Entity] is a public body, attach evidence of authority to sign and resolution or other documents authorizing execution of this Agreement.)

License No.: _____
(where applicable)

State: _____

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NOTICE TO PROCEED

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NOTICE TO PROCEED

Owner: City of Pikeville Owner's Project No.: _____
Engineer: Hussey Gay Bell Engineer's Project No.: 120300101
Contractor: _____ Contractor's Project No.: _____
Project: Pikeville 0.366 MGD Wastewater Treatment Plant
Contract Name: Pikeville 0.366 MGD Wastewater Treatment Plant
Effective Date of Contract: _____

Owner hereby notifies Contractor that the Contract Times under the above Contract will commence to run once the Notice to Proceed is issued and pursuant to Paragraph 4.01 of the General Conditions.

On that date, Contractor shall start performing its obligations under the Contract Documents. No Work will be done at the Site prior to such date.

In accordance with the Agreement:

The date by which Substantial Completion and readiness for final payment must be achieved is 730 days after the Notice to Proceed is issued.

Owner: City of Pikeville
By (*signature*): _____
Name (*printed*): _____
Title: _____
Date Issued: _____
Copy: Engineer

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PERFORMANCE BOND

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PERFORMANCE BOND

<p>Contractor</p> <p>Name: _____</p> <p>Address (principal place of business): _____</p>	<p>Surety</p> <p>Name: _____</p> <p>Address (principal place of business): _____</p>
<p>Owner</p> <p>Name: City of Pikeville</p> <p>Mailing address (principal place of business): 25 Municipal Drive, Pikeville, TN 37367</p>	<p>Contract</p> <p>Description (name and location): Pikeville 0.366 MGD Wastewater Treatment Plant 2468 Main Street, Pikeville, TN 37367</p> <p>Contract Price: \$ _____</p> <p>Effective Date of Contract: ____/____/____</p>
<p>Bond</p> <p>Bond Amount: \$ _____</p> <p>Date of Bond: ____/____/____</p> <p><i>(Date of Bond cannot be earlier than Effective Date of Contract)</i></p> <p>Modifications to this Bond form: <input type="checkbox"/> None <input type="checkbox"/> See Paragraph 16</p>	
<p>Surety and Contractor, intending to be legally bound hereby, subject to the terms set forth in this Performance Bond, do each cause this Performance Bond to be duly executed by an authorized officer, agent, or representative.</p>	
Contractor as Principal	Surety
_____ <i>(Full formal name of Contractor)</i>	_____ <i>(Full formal name of Surety) (corporate seal)</i>
By: _____ <i>(Signature)</i>	By: _____ <i>(Signature)(Attach Power of Attorney)</i>
Name: _____ <i>(Printed or typed)</i>	Name: _____ <i>(Printed or typed)</i>
Title: _____	Title: _____
Attest: _____ <i>(Signature)</i>	Attest: _____ <i>(Signature)</i>
Name: _____ <i>(Printed or typed)</i>	Name: _____ <i>(Printed or typed)</i>
Title: _____	Title: _____
<p><i>Notes: (1) Provide supplemental execution by any additional parties, such as joint venturers. (2) Any singular reference to Contractor, Surety, Owner, or other party is considered plural where applicable.</i></p>	

1. The Contractor and Surety, jointly and severally, bind themselves, their heirs, executors, administrators, successors, and assigns to the Owner for the performance of the Construction Contract, which is incorporated herein by reference.
2. If the Contractor performs the Construction Contract, the Surety and the Contractor shall have no obligation under this Bond, except when applicable to participate in a conference as provided in Paragraph 3.
3. If there is no Owner Default under the Construction Contract, the Surety's obligation under this Bond will arise after:
 - 3.1. The Owner first provides notice to the Contractor and the Surety that the Owner is considering declaring a Contractor Default. Such notice may indicate whether the Owner is requesting a conference among the Owner, Contractor, and Surety to discuss the Contractor's performance. If the Owner does not request a conference, the Surety may, within five (5) business days after receipt of the Owner's notice, request such a conference. If the Surety timely requests a conference, the Owner shall attend. Unless the Owner agrees otherwise, any conference requested under this Paragraph 3.1 will be held within ten (10) business days of the Surety's receipt of the Owner's notice. If the Owner, the Contractor, and the Surety agree, the Contractor shall be allowed a reasonable time to perform the Construction Contract, but such an agreement does not waive the Owner's right, if any, subsequently to declare a Contractor Default;
 - 3.2. The Owner declares a Contractor Default, terminates the Construction Contract and notifies the Surety; and
 - 3.3. The Owner has agreed to pay the Balance of the Contract Price in accordance with the terms of the Construction Contract to the Surety or to a contractor selected to perform the Construction Contract.
4. Failure on the part of the Owner to comply with the notice requirement in Paragraph 3.1 does not constitute a failure to comply with a condition precedent to the Surety's obligations, or release the Surety from its obligations, except to the extent the Surety demonstrates actual prejudice.
5. When the Owner has satisfied the conditions of Paragraph 3, the Surety shall promptly and at the Surety's expense take one of the following actions:
 - 5.1. Arrange for the Contractor, with the consent of the Owner, to perform and complete the Construction Contract;
 - 5.2. Undertake to perform and complete the Construction Contract itself, through its agents or independent contractors;
 - 5.3. Obtain bids or negotiated proposals from qualified contractors acceptable to the Owner for a contract for performance and completion of the Construction Contract, arrange for a contract to be prepared for execution by the Owner and a contractor selected with the Owners concurrence, to be secured with performance and payment bonds executed by a qualified surety equivalent to the bonds issued on the Construction Contract, and pay to the Owner the amount of damages as described in Paragraph 7 in excess of the Balance of the Contract Price incurred by the Owner as a result of the Contractor Default; or
 - 5.4. Waive its right to perform and complete, arrange for completion, or obtain a new contractor, and with reasonable promptness under the circumstances:

- 5.4.1 After investigation, determine the amount for which it may be liable to the Owner and, as soon as practicable after the amount is determined, make payment to the Owner; or
 - 5.4.2 Deny liability in whole or in part and notify the Owner, citing the reasons for denial.
6. If the Surety does not proceed as provided in Paragraph 5 with reasonable promptness, the Surety shall be deemed to be in default on this Bond seven days after receipt of an additional written notice from the Owner to the Surety demanding that the Surety perform its obligations under this Bond, and the Owner shall be entitled to enforce any remedy available to the Owner. If the Surety proceeds as provided in Paragraph 5.4, and the Owner refuses the payment, or the Surety has denied liability, in whole or in part, without further notice, the Owner shall be entitled to enforce any remedy available to the Owner.
7. If the Surety elects to act under Paragraph 5.1, 5.2, or 5.3, then the responsibilities of the Surety to the Owner will not be greater than those of the Contractor under the Construction Contract, and the responsibilities of the Owner to the Surety will not be greater than those of the Owner under the Construction Contract. Subject to the commitment by the Owner to pay the Balance of the Contract Price, the Surety is obligated, without duplication for:
 - 7.1. the responsibilities of the Contractor for correction of defective work and completion of the Construction Contract;
 - 7.2. additional legal, design professional, and delay costs resulting from the Contractor's Default, and resulting from the actions or failure to act of the Surety under Paragraph 5; and
 - 7.3. liquidated damages, or if no liquidated damages are specified in the Construction Contract, actual damages caused by delayed performance or non-performance of the Contractor.
8. If the Surety elects to act under Paragraph 5.1, 5.3, or 5.4, the Surety's liability is limited to the amount of this Bond.
9. The Surety shall not be liable to the Owner or others for obligations of the Contractor that are unrelated to the Construction Contract, and the Balance of the Contract Price will not be reduced or set off on account of any such unrelated obligations. No right of action will accrue on this Bond to any person or entity other than the Owner or its heirs, executors, administrators, successors, and assigns.
10. The Surety hereby waives notice of any change, including changes of time, to the Construction Contract or to related subcontracts, purchase orders, and other obligations.
11. Any proceeding, legal or equitable, under this Bond must be instituted in any court of competent jurisdiction in the location in which the work or part of the work is located and must be instituted within two years after a declaration of Contractor Default or within two years after the Contractor ceased working or within two years after the Surety refuses or fails to perform its obligations under this Bond, whichever occurs first. If the provisions of this paragraph are void or prohibited by law, the minimum periods of limitations available to sureties as a defense in the jurisdiction of the suit will be applicable.
12. Notice to the Surety, the Owner, or the Contractor must be mailed or delivered to the address shown on the page on which their signature appears.
13. When this Bond has been furnished to comply with a statutory or other legal requirement in the location where the construction was to be performed, any provision in this Bond conflicting with said statutory or legal requirement will be deemed deleted therefrom and provisions conforming to such

statutory or other legal requirement will be deemed incorporated herein. When so furnished, the intent is that this Bond will be construed as a statutory bond and not as a common law bond.

14. Definitions

- 14.1. *Balance of the Contract Price*—The total amount payable by the Owner to the Contractor under the Construction Contract after all proper adjustments have been made including allowance for the Contractor for any amounts received or to be received by the Owner in settlement of insurance or other claims for damages to which the Contractor is entitled, reduced by all valid and proper payments made to or on behalf of the Contractor under the Construction Contract.
 - 14.2. *Construction Contract*—The agreement between the Owner and Contractor identified on the cover page, including all Contract Documents and changes made to the agreement and the Contract Documents.
 - 14.3. *Contractor Default*—Failure of the Contractor, which has not been remedied or waived, to perform or otherwise to comply with a material term of the Construction Contract.
 - 14.4. *Owner Default*—Failure of the Owner, which has not been remedied or waived, to pay the Contractor as required under the Construction Contract or to perform and complete or comply with the other material terms of the Construction Contract.
 - 14.5. *Contract Documents*—All the documents that comprise the agreement between the Owner and Contractor.
15. If this Bond is issued for an agreement between a contractor and subcontractor, the term Contractor in this Bond will be deemed to be Subcontractor and the term Owner will be deemed to be Contractor.
16. Modifications to this Bond are as follows: None

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PAYMENT BOND

Prepared By



Endorsed By



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PAYMENT BOND

<p>Contractor</p> <p>Name: _____</p> <p>Address (principal place of business): _____</p>	<p>Surety</p> <p>Name: _____</p> <p>Address (principal place of business): _____</p>
<p>Owner</p> <p>Name: City of Pikeville</p> <p>Mailing address (principal place of business): 25 Municipal Drive, Pikeville, TN 37367</p>	<p>Contract</p> <p>Description (name and location): Pikeville 0.366 MGD Wastewater Treatment Plant 2468 Main Street, Pikeville, TN 37367</p> <p>Contract Price: \$ _____</p> <p>Effective Date of Contract: ____/____/____</p>
<p>Bond</p> <p>Bond Amount: \$ _____</p> <p>Date of Bond: ____/____/____</p> <p><i>(Date of Bond cannot be earlier than Effective Date of Contract)</i></p> <p>Modifications to this Bond form: <input type="checkbox"/> None <input type="checkbox"/> See Paragraph 18</p>	
<p>Surety and Contractor, intending to be legally bound hereby, subject to the terms set forth in this Payment Bond, do each cause this Payment Bond to be duly executed by an authorized officer, agent, or representative.</p>	
Contractor as Principal	Surety
<i>(Full formal name of Contractor)</i>	<i>(Full formal name of Surety) (corporate seal)</i>
By: _____ <i>(Signature)</i>	By: _____ <i>(Signature)(Attach Power of Attorney)</i>
Name: _____ <i>(Printed or typed)</i>	Name: _____ <i>(Printed or typed)</i>
Title: _____	Title: _____
Attest: _____ <i>(Signature)</i>	Attest: _____ <i>(Signature)</i>
Name: _____ <i>(Printed or typed)</i>	Name: _____ <i>(Printed or typed)</i>
Title: _____	Title: _____
<p><i>Notes: (1) Provide supplemental execution by any additional parties, such as joint venturers. (2) Any singular reference to Contractor, Surety, Owner, or other party is considered plural where applicable.</i></p>	

1. The Contractor and Surety, jointly and severally, bind themselves, their heirs, executors, administrators, successors, and assigns to the Owner to pay for labor, materials, and equipment furnished for use in the performance of the Construction Contract, which is incorporated herein by reference, subject to the following terms.
2. If the Contractor promptly makes payment of all sums due to Claimants, and defends, indemnifies, and holds harmless the Owner from claims, demands, liens, or suits by any person or entity seeking payment for labor, materials, or equipment furnished for use in the performance of the Construction Contract, then the Surety and the Contractor shall have no obligation under this Bond.
3. If there is no Owner Default under the Construction Contract, the Surety's obligation to the Owner under this Bond will arise after the Owner has promptly notified the Contractor and the Surety (at the address described in Paragraph 13) of claims, demands, liens, or suits against the Owner or the Owner's property by any person or entity seeking payment for labor, materials, or equipment furnished for use in the performance of the Construction Contract, and tendered defense of such claims, demands, liens, or suits to the Contractor and the Surety.
4. When the Owner has satisfied the conditions in Paragraph 3, the Surety shall promptly and at the Surety's expense defend, indemnify, and hold harmless the Owner against a duly tendered claim, demand, lien, or suit.
5. The Surety's obligations to a Claimant under this Bond will arise after the following:
 - 5.1. Claimants who do not have a direct contract with the Contractor
 - 5.1.1. have furnished a written notice of non-payment to the Contractor, stating with substantial accuracy the amount claimed and the name of the party to whom the materials were, or equipment was, furnished or supplied or for whom the labor was done or performed, within ninety (90) days after having last performed labor or last furnished materials or equipment included in the Claim; and
 - 5.1.2. have sent a Claim to the Surety (at the address described in Paragraph 13).
 - 5.2. Claimants who are employed by or have a direct contract with the Contractor have sent a Claim to the Surety (at the address described in Paragraph 13).
6. If a notice of non-payment required by Paragraph 5.1.1 is given by the Owner to the Contractor, that is sufficient to satisfy a Claimant's obligation to furnish a written notice of non-payment under Paragraph 5.1.1.
7. When a Claimant has satisfied the conditions of Paragraph 5.1 or 5.2, whichever is applicable, the Surety shall promptly and at the Surety's expense take the following actions:
 - 7.1. Send an answer to the Claimant, with a copy to the Owner, within sixty (60) days after receipt of the Claim, stating the amounts that are undisputed and the basis for challenging any amounts that are disputed; and
 - 7.2. Pay or arrange for payment of any undisputed amounts.
 - 7.3. The Surety's failure to discharge its obligations under Paragraph 7.1 or 7.2 will not be deemed to constitute a waiver of defenses the Surety or Contractor may have or acquire as to a Claim, except as to undisputed amounts for which the Surety and Claimant have reached agreement. If, however, the Surety fails to discharge its obligations under Paragraph 7.1 or 7.2, the Surety shall indemnify the Claimant for the reasonable attorney's fees the Claimant incurs thereafter to recover any sums found to be due and owing to the Claimant.

8. The Surety's total obligation will not exceed the amount of this Bond, plus the amount of reasonable attorney's fees provided under Paragraph 7.3, and the amount of this Bond will be credited for any payments made in good faith by the Surety.
9. Amounts owed by the Owner to the Contractor under the Construction Contract will be used for the performance of the Construction Contract and to satisfy claims, if any, under any construction performance bond. By the Contractor furnishing and the Owner accepting this Bond, they agree that all funds earned by the Contractor in the performance of the Construction Contract are dedicated to satisfying obligations of the Contractor and Surety under this Bond, subject to the Owner's priority to use the funds for the completion of the work.
10. The Surety shall not be liable to the Owner, Claimants, or others for obligations of the Contractor that are unrelated to the Construction Contract. The Owner shall not be liable for the payment of any costs or expenses of any Claimant under this Bond, and shall have under this Bond no obligation to make payments to or give notice on behalf of Claimants, or otherwise have any obligations to Claimants under this Bond.
11. The Surety hereby waives notice of any change, including changes of time, to the Construction Contract or to related subcontracts, purchase orders, and other obligations.
12. No suit or action will be commenced by a Claimant under this Bond other than in a court of competent jurisdiction in the state in which the project that is the subject of the Construction Contract is located or after the expiration of one year from the date (1) on which the Claimant sent a Claim to the Surety pursuant to Paragraph 5.1.2 or 5.2, or (2) on which the last labor or service was performed by anyone or the last materials or equipment were furnished by anyone under the Construction Contract, whichever of (1) or (2) first occurs. If the provisions of this paragraph are void or prohibited by law, the minimum period of limitation available to sureties as a defense in the jurisdiction of the suit will be applicable.
13. Notice and Claims to the Surety, the Owner, or the Contractor must be mailed or delivered to the address shown on the page on which their signature appears. Actual receipt of notice or Claims, however accomplished, will be sufficient compliance as of the date received.
14. When this Bond has been furnished to comply with a statutory or other legal requirement in the location where the construction was to be performed, any provision in this Bond conflicting with said statutory or legal requirement will be deemed deleted here from and provisions conforming to such statutory or other legal requirement will be deemed incorporated herein. When so furnished, the intent is that this Bond will be construed as a statutory bond and not as a common law bond.
15. Upon requests by any person or entity appearing to be a potential beneficiary of this Bond, the Contractor and Owner shall promptly furnish a copy of this Bond or shall permit a copy to be made.
16. Definitions
 - 16.1. *Claim*—A written statement by the Claimant including at a minimum:
 - 16.1.1. The name of the Claimant;
 - 16.1.2. The name of the person for whom the labor was done, or materials or equipment furnished;
 - 16.1.3. A copy of the agreement or purchase order pursuant to which labor, materials, or equipment was furnished for use in the performance of the Construction Contract;
 - 16.1.4. A brief description of the labor, materials, or equipment furnished;

- 16.1.5. The date on which the Claimant last performed labor or last furnished materials or equipment for use in the performance of the Construction Contract;
 - 16.1.6. The total amount earned by the Claimant for labor, materials, or equipment furnished as of the date of the Claim;
 - 16.1.7. The total amount of previous payments received by the Claimant; and
 - 16.1.8. The total amount due and unpaid to the Claimant for labor, materials, or equipment furnished as of the date of the Claim.
- 16.2. *Claimant*—An individual or entity having a direct contract with the Contractor or with a subcontractor of the Contractor to furnish labor, materials, or equipment for use in the performance of the Construction Contract. The term Claimant also includes any individual or entity that has rightfully asserted a claim under an applicable mechanic’s lien or similar statute against the real property upon which the Project is located. The intent of this Bond is to include without limitation in the terms of “labor, materials, or equipment” that part of the water, gas, power, light, heat, oil, gasoline, telephone service, or rental equipment used in the Construction Contract, architectural and engineering services required for performance of the work of the Contractor and the Contractor’s subcontractors, and all other items for which a mechanic’s lien may be asserted in the jurisdiction where the labor, materials, or equipment were furnished.
 - 16.3. *Construction Contract*—The agreement between the Owner and Contractor identified on the cover page, including all Contract Documents and all changes made to the agreement and the Contract Documents.
 - 16.4. *Owner Default*—Failure of the Owner, which has not been remedied or waived, to pay the Contractor as required under the Construction Contract or to perform and complete or comply with the other material terms of the Construction Contract.
 - 16.5. *Contract Documents*—All the documents that comprise the agreement between the Owner and Contractor.
17. If this Bond is issued for an agreement between a contractor and subcontractor, the term Contractor in this Bond will be deemed to be Subcontractor and the term Owner will be deemed to be Contractor.
 18. Modifications to this Bond are as follows: None

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APPLICATION FOR PAYMENT

Prepared By



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GUIDELINES FOR THE INTENDED USE OF EJCDC C-620, APPLICATION FOR PAYMENT

1.0 PURPOSE AND INTENDED USE OF THE DOCUMENT

The Application for Payment is used to facilitate periodic progress payments to the Contractor for Work completed and for stored materials and equipment (referred to in this document as "Stored Materials").

For additional information regarding the Application for Payment, see EJCDC® C-700, Standard General Conditions of the Construction Contract (2018), Paragraph 15.01, and EJCDC® C-001, Commentary on the 2018 EJCDC Construction Documents (2018).

2.0 APPLICATION FOR PAYMENT OVERVIEW

This document was prepared in Microsoft Excel due to the number of calculations involved in the preparation of the Application for Payment. The application consists of a Summary worksheet, and 3 supporting worksheets: Lump Sum worksheet, Unit Price worksheet, and Stored Materials worksheet.

- 2.1 *Summary Worksheet* — calculates the amount to be paid to the Contractor at the end of each Application for Payment period. This calculation imports numbers from the supporting worksheets to determine the value of the Work completed and Stored Materials, calculate retainage, and deduct amounts previously paid to determine the amount the Contractor should be paid for the current application period. Application periods are typically one month; however these periods may be extended when Contractor's efforts do not result in the billable completion of Work or storage of materials and equipment during the payment period.

- 2.2 *Lump Sum Worksheet* — calculates the total value for completed Work for which compensation is paid on a Lump Sum basis. The schedule of values included in this worksheet reflects a breakdown of lump sum Work items to which Contractor and Engineer have agreed, pursuant to Article 2 of the General Conditions. Costs for Stored Materials associated with lump sum items are included on this worksheet to calculate the total value for completed lump sum Work and associated Stored Materials. This total is exported to the Summary worksheet. Separate totals for Work Completed and for materials currently stored are also exported to the Summary worksheet for use in calculating the amount of retainage to be held for each.

- 2.3 *Unit Price Worksheet* — calculates the total value for completed Work for which compensation is paid on a Unit Price basis. The schedule of values included in this spreadsheet is typically a tabulation of Unit Price items from the Agreement. Costs for Stored Materials associated with unit price items are included in this worksheet to calculate the total value for completed Unit Price Work and associated Stored Materials. This total is exported to the Summary worksheet. Separate totals for Work Completed and for Materials Currently Stored are also exported to the Summary worksheet for use in calculating the amount of retainage to be held for each.

2.4 *Stored Materials Worksheet* — calculates the total value for materials and equipment that have been purchased and are being stored until they are incorporated into the Work. This worksheet adds materials and equipment to the worksheet as they are brought to the site and stored; such Stored Materials are then deducted from the Stored Materials worksheet total as they are incorporated into the Work, providing a running net value for the materials and equipment remaining in storage. The values of Stored Materials must be manually added to the Lump Sum or Unit Price line items. These do not automatically update when changes are made. The amount of materials remaining in storage is eligible for payment but must be tracked separately from Work completed since different retainage rates may apply to Work completed and Stored Materials.

3.0 Instructions for filling out the Payment Application form

- 3.1 Project-specific information is to be entered in the top portion (header) of the Summary worksheet. This same information will automatically be copied to the other worksheets to complete the headers on all other worksheets.
- 3.2 Outside of the header, data can be entered in non-shaded cells when the sheet is protected. Cells shaded light blue contain equations that will automatically transfer data from other cells or make calculations to complete the worksheet. Altering any of these cells can result in errors in the Application for Payment. It is recommended that the worksheets be protected at all times unless alterations are deliberately being made to the Application for Payment form other than to enter data. See Paragraph 4.0 below for information on Protection of Worksheets.
- 3.3 Enter information regarding each item in the Lump Sum and/or Unit Price worksheets. For Lump Sum projects, each item should represent an item in the schedule of values prepared by the Contractor and approved by the Engineer/Owner, breaking down the Lump Sum amount into measurable components. For Unit Price contracts, use numbers from the Agreement as the schedule of values. Specific information on the data to be entered into each column may be seen by clicking on the header description for that column. Similar comments may be seen for cells in the "Totals" row that indicates how the number is calculated and where this number is exported to another part of the spreadsheet. See the Commentary for additional information.
- 3.4 The equations in the Summary worksheet use numbers imported from both the Lump Sum and Unit Price worksheets. Projects will typically either use the Lump Sum or the Unit Price worksheet, but some projects may use both. If one of the worksheets is not used, it should be hidden and not deleted. If it is deleted, Users will need to correct the equations in the Summary worksheet by unprotecting the worksheet and editing the equations. To hide a worksheet, right click on the worksheet tab at the bottom of the worksheet and select "Hide." To unhide a worksheet, right click on any worksheet tab and select "Unhide," and then select the worksheet to unhide and click "Okay." This same process may be used to hide these Guidelines for Use.

3.5 EJCDC C-620 contains calculation functions that are provided solely for the convenience of the user. EJCDC and its Sponsoring Organizations do not warrant or guarantee the accuracy or completeness of any information generated by the calculator.

4.0 Protection of Worksheets

- 4.1 The cells in this Workbook that create the forms or contain equations have been coded to "lock" the cells that should not be altered. It is recommended that the Workbook be Protected (cells locked) at all times unless it is necessary to add or delete rows. Directions for adding and deleting rows are provided in the next section. Passwords can be used to lock the Protect / Unprotect settings on spreadsheets, however the worksheets in this workbook do not require a password.
- 4.2 To unprotect a worksheet, click on the "Review" menu tab at the top of Excel, then click "Unprotect Sheet." To protect a worksheet, click on the "Review" menu tab at the top of Excel, then click "Protect Sheet." This will open a dialog box in which the User is allowed to select protection options. It is recommended that only the top two checkboxes for "Select Locked Cells" and "Select Unlocked Cells" be checked. This will reset the protection for the Worksheet.

5.0 Adding and Deleting Rows

- 5.1 A limited number of blank rows are provided in the Lump Sum, Unit Price, and Stored Material worksheets. Additional rows may be added to these worksheets by the User. The first step in this process is to unprotect the worksheet as previously discussed. After the sheet is unprotected, move with caution to prevent inadvertently deleting any cells that contain equations. To insert a row, right click in the row heading at the left of the spreadsheet and select "Insert." A new row will be inserted at the location where the cursor was placed in the row heading. If more than one new row is desired, left click and drag the cursor to include the desired number of rows, right click in the selected row headings and then select "Insert." It is important that the line immediately above the "Totals" row not be included in the rows selected. Doing so will require that equations in the "Totals" row be adjusted. When rows are inserted, Excel automatically adjusts the equations to include the new rows, unless the row directly above the "Totals" row is also selected.
- 5.2 After new rows are inserted, it is important to copy a line from one of the original rows so correct formatting and equations are copied into each new row. To do this, select the row to be copied by clicking the cell in Column A and dragging the cursor to the last column in the table. Then select "Copy" from the menu or type CTRL+C to copy the cells. Excel will show that this row has been copied by showing a moving dashed line around the cells that are to be copied. Then select the new rows into which the information is to be copied as before and select Paste from the menu or type CTRL+V.
- 5.3 To delete an unused row, right click in the row heading on the left of the spreadsheet for the row to be deleted and select "Delete." The selected row will be deleted. If more than one row is to be deleted, left click and drag the cursor to the desired number of rows to be deleted and then right click to open the menu and select "Delete." Unlike the admonition on adding new rows, it is okay to delete the row just above the "Totals" row.
- 5.4 After rows have been added or deleted, it is important reset the worksheet protection.

6.0 Saving Files

This file is provided as a Microsoft[®] Excel Open XML workbook template (.xltx) to prevent this file from being inadvertently changed. When an application for payment is created for a specific project it should be saved as an Excel workbook (.xlsx) file. To do this, select Save As (F12), type in a new file name and select Excel Workbook (.xlsx) from the drop down Save As Type menu.

7.0 License Agreement

This document is subject to the terms and conditions of the License Agreement, 2018 EJCDC[®] Construction Series Documents. A copy of the License Agreement was furnished at the time of purchase of this document, and is available for review at www.ejcdc.org and the websites of EJCDC's sponsoring organizations.

Contractor's Application for Payment

Owner: <u>City of Pikeville</u>	Owner's Project No.: _____
Engineer: <u>Hussey Gay Bell</u>	Engineer's Project No.: <u>120300101</u>
Contractor: _____	Contractor's Project No.: _____
Project: <u>Pikeville 0.366 MGD Wastewater Treatment Plant</u>	
Contract: <u>Pikeville 0.366 MGD Wastewater Treatment Plant</u>	

Application No.: _____ **Application Date:** _____

Application Period: **From** _____ **to** _____

1. Original Contract Price	\$ -
2. Net change by Change Orders	\$ -
3. Current Contract Price (Line 1 + Line 2)	\$ -
4. Total Work completed and materials stored to date (Sum of Column G Lump Sum Total and Column J Unit Price Total)	\$ -
5. Retainage	
a. _____ X \$ - Work Completed	\$ -
b. _____ X \$ - Stored Materials	\$ -
c. Total Retainage (Line 5.a + Line 5.b)	\$ -
6. Amount eligible to date (Line 4 - Line 5.c)	\$ -
7. Less previous payments (Line 6 from prior application)	
8. Amount due this application	\$ -
9. Balance to finish, including retainage (Line 3 - Line 4)	\$ -

Contractor's Certification

The undersigned Contractor certifies, to the best of its knowledge, the following:

(1) All previous progress payments received from Owner on account of Work done under the Contract have been applied on account to discharge Contractor's legitimate obligations incurred in connection with the Work covered by prior Applications for Payment;

(2) Title to all Work, materials and equipment incorporated in said Work, or otherwise listed in or covered by this Application for Payment, will pass to Owner at time of payment free and clear of all liens, security interests, and encumbrances (except such as are covered by a bond acceptable to Owner indemnifying Owner against any such liens, security interest, or encumbrances); and

(3) All the Work covered by this Application for Payment is in accordance with the Contract Documents and is not defective.

Contractor: _____

Signature: _____ **Date:** _____

Recommended by Engineer	Approved by Owner
By: _____	By: _____
Title: _____	Title: _____
Date: _____	Date: _____
Approved by Funding Agency	
By: _____	By: _____
Title: _____	Title: _____
Date: _____	Date: _____

Progress Estimate - Unit Price Work

Contractor's Application for Payment

Owner: City of Pikeville
Engineer: Hussey Gay Bell
Contractor: _____
Project: Pikeville 0.366 MGD Wastewater Treatment Plant
Contract: Pikeville 0.366 MGD Wastewater Treatment Plant

Owner's Project No.: _____
Engineer's Project No.: 120300101
Contractor's Project No.: _____

Application No.: _____ **Application Period:** **From** _____ **to** _____ **Application Date:** _____

A	B	C	D	E	F	G	H	I	J	K	L
Bid Item No.	Description	Contract Information				Work Completed		Materials Currently Stored (not in G) (\$)	Work Completed and Materials Stored to Date (H + I) (\$)	% of Value of Item (I / F) (%)	Balance to Finish (F - J) (\$)
		Item Quantity	Units	Unit Price (\$)	Value of Bid Item (C X E) (\$)	Estimated Quantity Incorporated in the Work	Value of Work Completed to Date (E X G) (\$)				
Original Contract											
					-		-		-		-
					-		-		-		-
					-		-		-		-
					-		-		-		-
					-		-		-		-
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					-		-		-		-
					-		-		-		-
					-		-		-		-
					-		-		-		-
Original Contract Totals					\$	-		\$	-	\$	-

Progress Estimate - Unit Price Work

Contractor's Application for Payment

Owner:	City of Pikeville	Owner's Project No.:	
Engineer:	Hussey Gay Bell	Engineer's Project No.:	120300101
Contractor:		Contractor's Project No.:	
Project:	Pikeville 0.366 MGD Wastewater Treatment Plant		
Contract:	Pikeville 0.366 MGD Wastewater Treatment Plant		

Application No.: _____ Application Period: From _____ to _____ Application Date: _____

A	B	C	D	E	F	G	H	I	J	K	L
Bid Item No.	Description	Contract Information				Work Completed		Materials Currently Stored (not in G) (\$)	Work Completed and Materials Stored to Date (H + I) (\$)	% of Value of Item (I / F) (%)	Balance to Finish (F - J) (\$)
		Item Quantity	Units	Unit Price (\$)	Value of Bid Item (C X E) (\$)	Estimated Quantity Incorporated in the Work	Value of Work Completed to Date (E X G) (\$)				
Change Orders											
					-		-		-		-
					-		-		-		-
					-		-		-		-
					-		-		-		-
					-		-		-		-
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					-		-		-		-
					-		-		-		-
					-		-		-		-
					-		-		-		-
					Change Order Totals	\$	-	\$	-	\$	-
Original Contract and Change Orders											
					Project Totals	\$	-	\$	-	\$	-

Stored Materials Summary

Contractor's Application for Payment

Owner:	City of Pikeville		Owner's Project No.:	
Engineer:	Hussey Gay Bell		Engineer's Project No.:	120300101
Contractor:			Contractor's Project No.:	
Project:	Pikeville 0.366 MGD Wastewater Treatment Plant			
Contract:	Pikeville 0.366 MGD Wastewater Treatment Plant			

Application No.:		Application Period:	From		to		Application Date:	
------------------	--	---------------------	------	--	----	--	-------------------	--

A	B	C	D	E	F	G	H	I	J	K	L	M	
Item No. (Lump Sum Tab) or Bid Item No. (Unit Price Tab)	Supplier Invoice No.	Submittal No. (with Specification Section No.)	Description of Materials or Equipment Stored	Storage Location	Application No. When Materials Placed in Storage	Materials Stored			Incorporated in Work			Materials Remaining in Storage (I-L) (\$)	
						Previous Amount Stored (\$)	Amount Stored this Period (\$)	Amount Stored to Date (G+H) (\$)	Amount Previously Incorporated in the Work (\$)	Amount Incorporated in the Work this Period (\$)	Total Amount Incorporated in the Work (J+K) (\$)		
								-			-	-	
								-			-	-	
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								-			-	-	
								-			-	-	
								-			-	-	
Totals						\$	-	\$	-	\$	-	\$	-

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CERTIFICATE OF SUBSTANTIAL COMPLETION

Prepared By



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CERTIFICATE OF SUBSTANTIAL COMPLETION

Owner: City of Pikeville
Engineer: Hussey Gay Bell
Contractor:
Project: Pikeville 0.366 MGD Wastewater Treatment Plant
Contract Name: Pikeville 0.366 MGD Wastewater Treatment Plant

Owner's Project No.:
Engineer's Project No.: 120300101
Contractor's Project No.:

This Preliminary Final Certificate of Substantial Completion applies to:

All Work The following specified portions of the Work:

Depending on the project type, description should include but not limited to:

- Linear feet, diameter, and type of force main, gravity sewer or low-pressure sewer
- Proposed treatment process
- Treatment/storage/pumping capacity
- For line rehabilitation, include: linear feet and size by activity, e.g, replacement, pipe-bursting, cured-in-place, slip-line, TV inspection, smoke testing; number of man hole or service lateral rehabs.

Date of Substantial Completion will be within **730** days of the Notice to Proceed is issued.

The Work to which this Certificate applies has been inspected by authorized representatives of Owner, Contractor, and Engineer, and found to be substantially complete. The Date of Substantial Completion of the Work or portion thereof designated above is hereby established, subject to the provisions of the Contract pertaining to Substantial Completion. The date of Substantial Completion in the final Certificate of Substantial Completion marks the commencement of the contractual correction period and applicable warranties required by the Contract.

A punch list of items to be completed or corrected is attached to this Certificate. This list may not be all-inclusive, and the failure to include any items on such list does not alter the responsibility of the Contractor to complete all Work in accordance with the Contract Documents.

Amendments of contractual responsibilities recorded in this Certificate should be the product of mutual agreement of Owner and Contractor; see Paragraph 15.03.D of the General Conditions.

The responsibilities between Owner and Contractor for security, operation, safety, maintenance, heat, utilities, insurance, and warranties upon Owner's use or occupancy of the Work must be as provided in the Contract, except as amended as follows:

Amendments to Owner's Responsibilities: None As follows:

[List amendments to Owner's Responsibilities]

Amendments to Contractor's Responsibilities: None As follows:

[List amendments to Contractor's Responsibilities]

The following documents are attached to and made a part of this Certificate:

[List attachments such as punch list; other documents]

This Certificate does not constitute an acceptance of Work not in accordance with the Contract Documents, nor is it a release of Contractor's obligation to complete the Work in accordance with the Contract Documents.

Engineer

By (*signature*): _____

Name (*printed*): _____

Title: _____

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NOTICE OF ACCEPTABILITY OF WORK

Prepared By



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NOTICE OF ACCEPTABILITY OF WORK

Owner: City of Pikeville
Engineer: Hussey Gay Bell
Contractor:
Project: Pikeville 0.366 MGD Wastewater Treatment Plant
Contract Name: Pikeville 0.366 MGD Wastewater Treatment Plant

Owner's Project No.:
Engineer's Project No.: 120300101
Contractor's Project No.:

Notice Date: / /

Effective Date of the Construction
Contract: / /

The Engineer hereby gives notice to the Owner and Contractor that Engineer recommends final payment to Contractor, and that the Work furnished and performed by Contractor under the Construction Contract is acceptable, expressly subject to the provisions of the Construction Contract's Contract Documents and of the Agreement between Owner and Engineer for Professional Services. This Notice of Acceptability of Work is made expressly subject to the following terms and conditions to which all who receive and rely on said Notice agree:

1. This Notice has been prepared with the skill and care ordinarily used by members of the engineering profession practicing under similar conditions at the same time and in the same locality.
2. This Notice reflects and is an expression of the Engineer's professional opinion.
3. This Notice has been prepared to the best of Engineer's knowledge, information, and belief as of the Notice Date.
4. This Notice is based entirely on and expressly limited by the scope of services Engineer has been employed by Owner to perform or furnish during construction of the Project (including observation of the Contractor's Work) under the Owner-Engineer Agreement, and applies only to facts that are within Engineer's knowledge or could reasonably have been ascertained by Engineer as a result of carrying out the responsibilities specifically assigned to Engineer under such Owner-Engineer Agreement.
5. This Notice is not a guarantee or warranty of Contractor's performance under the Construction Contract, an acceptance of Work that is not in accordance with the Contract Documents, including but not limited to defective Work discovered after final inspection, nor an assumption of responsibility for any failure of Contractor to furnish and perform the Work thereunder in accordance with the Contract Documents, or to otherwise comply with the Contract Documents or the terms of any special guarantees specified therein.
6. This Notice does not relieve Contractor of any surviving obligations under the Construction Contract, and is subject to Owner's reservations of rights with respect to completion and final payment.

Engineer

By *(signature)*: _____

Name *(printed)*: _____

Title: _____

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STANDARD GENERAL CONDITIONS OF THE CONSTRUCTION CONTRACT

Prepared By



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STANDARD GENERAL CONDITIONS OF THE CONSTRUCTION CONTRACT

ARTICLE 1—DEFINITIONS AND TERMINOLOGY

1.01 *Defined Terms*

- A. Wherever used in the Bidding Requirements or Contract Documents, a term printed with initial capital letters, including the term's singular and plural forms, will have the meaning indicated in the definitions below. In addition to terms specifically defined, terms with initial capital letters in the Contract Documents include references to identified articles and paragraphs, and the titles of other documents or forms.
1. *Addenda*—Written or graphic instruments issued prior to the opening of Bids which clarify, correct, or change the Bidding Requirements or the proposed Contract Documents.
 2. *Agreement*—The written instrument, executed by Owner and Contractor, that sets forth the Contract Price and Contract Times, identifies the parties and the Engineer, and designates the specific items that are Contract Documents.
 3. *Application for Payment*—The document prepared by Contractor, in a form acceptable to Engineer, to request progress or final payments, and which is to be accompanied by such supporting documentation as is required by the Contract Documents.
 4. *Bid*—The offer of a Bidder submitted on the prescribed form setting forth the prices for the Work to be performed.
 5. *Bidder*—An individual or entity that submits a Bid to Owner.
 6. *Bidding Documents*—The Bidding Requirements, the proposed Contract Documents, and all Addenda.
 7. *Bidding Requirements*—The Advertisement or invitation to bid, Instructions to Bidders, Bid Bond or other Bid security, if any, the Bid Form, and the Bid with any attachments.
 8. *Change Order*—A document which is signed by Contractor and Owner and authorizes an addition, deletion, or revision in the Work or an adjustment in the Contract Price or the Contract Times, or other revision to the Contract, issued on or after the Effective Date of the Contract.
 9. *Change Proposal*—A written request by Contractor, duly submitted in compliance with the procedural requirements set forth herein, seeking an adjustment in Contract Price or Contract Times; contesting an initial decision by Engineer concerning the requirements of the Contract Documents or the acceptability of Work under the Contract Documents; challenging a set-off against payments due; or seeking other relief with respect to the terms of the Contract.
 10. *Claim*
 - a. A demand or assertion by Owner directly to Contractor, duly submitted in compliance with the procedural requirements set forth herein, seeking an adjustment of Contract Price or Contract Times; contesting an initial decision by Engineer concerning the

- requirements of the Contract Documents or the acceptability of Work under the Contract Documents; contesting Engineer's decision regarding a Change Proposal; seeking resolution of a contractual issue that Engineer has declined to address; or seeking other relief with respect to the terms of the Contract.
- b. A demand or assertion by Contractor directly to Owner, duly submitted in compliance with the procedural requirements set forth herein, contesting Engineer's decision regarding a Change Proposal, or seeking resolution of a contractual issue that Engineer has declined to address.
 - c. A demand or assertion by Owner or Contractor, duly submitted in compliance with the procedural requirements set forth herein, made pursuant to Paragraph 12.01.A.4, concerning disputes arising after Engineer has issued a recommendation of final payment.
 - d. A demand for money or services by a third party is not a Claim.
11. *Constituent of Concern*—Asbestos, petroleum, radioactive materials, polychlorinated biphenyls (PCBs), lead-based paint (as defined by the HUD/EPA standard), hazardous waste, and any substance, product, waste, or other material of any nature whatsoever that is or becomes listed, regulated, or addressed pursuant to Laws and Regulations regulating, relating to, or imposing liability or standards of conduct concerning, any hazardous, toxic, or dangerous waste, substance, or material.
12. *Contract*—The entire and integrated written contract between Owner and Contractor concerning the Work.
13. *Contract Documents*—Those items so designated in the Agreement, and which together comprise the Contract.
14. *Contract Price*—The money that Owner has agreed to pay Contractor for completion of the Work in accordance with the Contract Documents.
15. *Contract Times*—The number of days or the dates by which Contractor shall: (a) achieve Milestones, if any; (b) achieve Substantial Completion; and (c) complete the Work.
16. *Contractor*—The individual or entity with which Owner has contracted for performance of the Work.
17. *Cost of the Work*—See Paragraph 13.01 for definition.
18. *Drawings*—The part of the Contract that graphically shows the scope, extent, and character of the Work to be performed by Contractor.
19. *Effective Date of the Contract*—The date, indicated in the Agreement, on which the Contract becomes effective.
20. *Electronic Document*—Any Project-related correspondence, attachments to correspondence, data, documents, drawings, information, or graphics, including but not limited to Shop Drawings and other Submittals, that are in an electronic or digital format.
21. *Electronic Means*—Electronic mail (email), upload/download from a secure Project website, or other communications methods that allow: (a) the transmission or communication of Electronic Documents; (b) the documentation of transmissions, including sending and receipt; (c) printing of the transmitted Electronic Document by the

recipient; (d) the storage and archiving of the Electronic Document by sender and recipient; and (e) the use by recipient of the Electronic Document for purposes permitted by this Contract. Electronic Means does not include the use of text messaging, or of Facebook, Twitter, Instagram, or similar social media services for transmission of Electronic Documents.

22. *Engineer*—The individual or entity named as such in the Agreement.
23. *Field Order*—A written order issued by Engineer which requires minor changes in the Work but does not change the Contract Price or the Contract Times.
24. *Hazardous Environmental Condition*—The presence at the Site of Constituents of Concern in such quantities or circumstances that may present a danger to persons or property exposed thereto.
 - a. The presence at the Site of materials that are necessary for the execution of the Work, or that are to be incorporated into the Work, and that are controlled and contained pursuant to industry practices, Laws and Regulations, and the requirements of the Contract, is not a Hazardous Environmental Condition.
 - b. The presence of Constituents of Concern that are to be removed or remediated as part of the Work is not a Hazardous Environmental Condition.
 - c. The presence of Constituents of Concern as part of the routine, anticipated, and obvious working conditions at the Site, is not a Hazardous Environmental Condition.
25. *Laws and Regulations; Laws or Regulations*—Any and all applicable laws, statutes, rules, regulations, ordinances, codes, and binding decrees, resolutions, and orders of any and all governmental bodies, agencies, authorities, and courts having jurisdiction.
26. *Liens*—Charges, security interests, or encumbrances upon Contract-related funds, real property, or personal property.
27. *Milestone*—A principal event in the performance of the Work that the Contract requires Contractor to achieve by an intermediate completion date, or by a time prior to Substantial Completion of all the Work.
28. *Notice of Award*—The written notice by Owner to a Bidder of Owner's acceptance of the Bid.
29. *Notice to Proceed*—A written notice by Owner to Contractor fixing the date on which the Contract Times will commence to run and on which Contractor shall start to perform the Work.
30. *Owner*—The individual or entity with which Contractor has contracted regarding the Work, and which has agreed to pay Contractor for the performance of the Work, pursuant to the terms of the Contract.
31. *Progress Schedule*—A schedule, prepared and maintained by Contractor, describing the sequence and duration of the activities comprising Contractor's plan to accomplish the Work within the Contract Times.
32. *Project*—The total undertaking to be accomplished for Owner by engineers, contractors, and others, including planning, study, design, construction, testing, commissioning, and start-up, and of which the Work to be performed under the Contract Documents is a part.

33. *Resident Project Representative*—The authorized representative of Engineer assigned to assist Engineer at the Site. As used herein, the term Resident Project Representative (RPR) includes any assistants or field staff of Resident Project Representative.
34. *Samples*—Physical examples of materials, equipment, or workmanship that are representative of some portion of the Work and that establish the standards by which such portion of the Work will be judged.
35. *Schedule of Submittals*—A schedule, prepared and maintained by Contractor, of required submittals and the time requirements for Engineer’s review of the submittals.
36. *Schedule of Values*—A schedule, prepared and maintained by Contractor, allocating portions of the Contract Price to various portions of the Work and used as the basis for reviewing Contractor’s Applications for Payment.
37. *Shop Drawings*—All drawings, diagrams, illustrations, schedules, and other data or information that are specifically prepared or assembled by or for Contractor and submitted by Contractor to illustrate some portion of the Work. Shop Drawings, whether approved or not, are not Drawings and are not Contract Documents.
38. *Site*—Lands or areas indicated in the Contract Documents as being furnished by Owner upon which the Work is to be performed, including rights-of-way and easements, and such other lands or areas furnished by Owner which are designated for the use of Contractor.
39. *Specifications*—The part of the Contract that consists of written requirements for materials, equipment, systems, standards, and workmanship as applied to the Work, and certain administrative requirements and procedural matters applicable to the Work.
40. *Subcontractor*—An individual or entity having a direct contract with Contractor or with any other Subcontractor for the performance of a part of the Work.
41. *Submittal*—A written or graphic document, prepared by or for Contractor, which the Contract Documents require Contractor to submit to Engineer, or that is indicated as a Submittal in the Schedule of Submittals accepted by Engineer. Submittals may include Shop Drawings and Samples; schedules; product data; Owner-delegated designs; sustainable design information; information on special procedures; testing plans; results of tests and evaluations, source quality-control testing and inspections, and field or Site quality-control testing and inspections; warranties and certifications; Suppliers’ instructions and reports; records of delivery of spare parts and tools; operations and maintenance data; Project photographic documentation; record documents; and other such documents required by the Contract Documents. Submittals, whether or not approved or accepted by Engineer, are not Contract Documents. Change Proposals, Change Orders, Claims, notices, Applications for Payment, and requests for interpretation or clarification are not Submittals.
42. *Substantial Completion*—The time at which the Work (or a specified part thereof) has progressed to the point where, in the opinion of Engineer, the Work (or a specified part thereof) is sufficiently complete, in accordance with the Contract Documents, so that the Work (or a specified part thereof) can be utilized for the purposes for which it is intended. The terms “substantially complete” and “substantially completed” as applied to all or part of the Work refer to Substantial Completion of such Work.

43. *Successful Bidder*—The Bidder to which the Owner makes an award of contract.
44. *Supplementary Conditions*—The part of the Contract that amends or supplements these General Conditions.
45. *Supplier*—A manufacturer, fabricator, supplier, distributor, or vendor having a direct contract with Contractor or with any Subcontractor to furnish materials or equipment to be incorporated in the Work by Contractor or a Subcontractor.
46. *Technical Data*
- a. Those items expressly identified as Technical Data in the Supplementary Conditions, with respect to either (1) existing subsurface conditions at or adjacent to the Site, or existing physical conditions at or adjacent to the Site including existing surface or subsurface structures (except Underground Facilities) or (2) Hazardous Environmental Conditions at the Site.
 - b. If no such express identifications of Technical Data have been made with respect to conditions at the Site, then Technical Data is defined, with respect to conditions at the Site under Paragraphs 5.03, 5.04, and 5.06, as the data contained in boring logs, recorded measurements of subsurface water levels, assessments of the condition of subsurface facilities, laboratory test results, and other factual, objective information regarding conditions at the Site that are set forth in any geotechnical, environmental, or other Site or facilities conditions report prepared for the Project and made available to Contractor.
 - c. Information and data regarding the presence or location of Underground Facilities are not intended to be categorized, identified, or defined as Technical Data, and instead Underground Facilities are shown or indicated on the Drawings.
47. *Underground Facilities*—All active or not-in-service underground lines, pipelines, conduits, ducts, encasements, cables, wires, manholes, vaults, tanks, tunnels, or other such facilities or systems at the Site, including but not limited to those facilities or systems that produce, transmit, distribute, or convey telephone or other communications, cable television, fiber optic transmissions, power, electricity, light, heat, gases, oil, crude oil products, liquid petroleum products, water, steam, waste, wastewater, storm water, other liquids or chemicals, or traffic or other control systems. An abandoned facility or system is not an Underground Facility.
48. *Unit Price Work*—Work to be paid for on the basis of unit prices.
49. *Work*—The entire construction or the various separately identifiable parts thereof required to be provided under the Contract Documents. Work includes and is the result of performing or providing all labor, services, and documentation necessary to produce such construction; furnishing, installing, and incorporating all materials and equipment into such construction; and may include related services such as testing, start-up, and commissioning, all as required by the Contract Documents.
50. *Work Change Directive*—A written directive to Contractor issued on or after the Effective Date of the Contract, signed by Owner and recommended by Engineer, ordering an addition, deletion, or revision in the Work.

1.02 Terminology

- A. The words and terms discussed in Paragraphs 1.02.B, C, D, and E are not defined terms that require initial capital letters, but, when used in the Bidding Requirements or Contract Documents, have the indicated meaning.
- B. *Intent of Certain Terms or Adjectives:* The Contract Documents include the terms “as allowed,” “as approved,” “as ordered,” “as directed” or terms of like effect or import to authorize an exercise of professional judgment by Engineer. In addition, the adjectives “reasonable,” “suitable,” “acceptable,” “proper,” “satisfactory,” or adjectives of like effect or import are used to describe an action or determination of Engineer as to the Work. It is intended that such exercise of professional judgment, action, or determination will be solely to evaluate, in general, the Work for compliance with the information in the Contract Documents and with the design concept of the Project as a functioning whole as shown or indicated in the Contract Documents (unless there is a specific statement indicating otherwise). The use of any such term or adjective is not intended to and shall not be effective to assign to Engineer any duty or authority to supervise or direct the performance of the Work, or any duty or authority to undertake responsibility contrary to the provisions of Article 10 or any other provision of the Contract Documents.
- C. *Day:* The word “day” means a calendar day of 24 hours measured from midnight to the next midnight.
- D. *Defective:* The word “defective,” when modifying the word “Work,” refers to Work that is unsatisfactory, faulty, or deficient in that it:
1. does not conform to the Contract Documents;
 2. does not meet the requirements of any applicable inspection, reference standard, test, or approval referred to in the Contract Documents; or
 3. has been damaged prior to Engineer’s recommendation of final payment (unless responsibility for the protection thereof has been assumed by Owner at Substantial Completion in accordance with Paragraph 15.03 or Paragraph 15.04).
- E. *Furnish, Install, Perform, Provide*
1. The word “furnish,” when used in connection with services, materials, or equipment, means to supply and deliver said services, materials, or equipment to the Site (or some other specified location) ready for use or installation and in usable or operable condition.
 2. The word “install,” when used in connection with services, materials, or equipment, means to put into use or place in final position said services, materials, or equipment complete and ready for intended use.
 3. The words “perform” or “provide,” when used in connection with services, materials, or equipment, means to furnish and install said services, materials, or equipment complete and ready for intended use.
 4. If the Contract Documents establish an obligation of Contractor with respect to specific services, materials, or equipment, but do not expressly use any of the four words “furnish,” “install,” “perform,” or “provide,” then Contractor shall furnish and install said services, materials, or equipment complete and ready for intended use.

- F. *Contract Price or Contract Times*: References to a change in “Contract Price or Contract Times” or “Contract Times or Contract Price” or similar, indicate that such change applies to (1) Contract Price, (2) Contract Times, or (3) both Contract Price and Contract Times, as warranted, even if the term “or both” is not expressed.
- G. Unless stated otherwise in the Contract Documents, words or phrases that have a well-known technical or construction industry or trade meaning are used in the Contract Documents in accordance with such recognized meaning.

ARTICLE 2—PRELIMINARY MATTERS

2.01 *Delivery of Performance and Payment Bonds; Evidence of Insurance*

- A. *Performance and Payment Bonds*: When Contractor delivers the signed counterparts of the Agreement to Owner, Contractor shall also deliver to Owner the performance bond and payment bond (if the Contract requires Contractor to furnish such bonds).
- B. *Evidence of Contractor’s Insurance*: When Contractor delivers the signed counterparts of the Agreement to Owner, Contractor shall also deliver to Owner, with copies to each additional insured (as identified in the Contract), the certificates, endorsements, and other evidence of insurance required to be provided by Contractor in accordance with Article 6, except to the extent the Supplementary Conditions expressly establish other dates for delivery of specific insurance policies.
- C. *Evidence of Owner’s Insurance*: After receipt of the signed counterparts of the Agreement and all required bonds and insurance documentation, Owner shall promptly deliver to Contractor, with copies to each additional insured (as identified in the Contract), the certificates and other evidence of insurance required to be provided by Owner under Article 6.

2.02 *Copies of Documents*

- A. Owner shall furnish to Contractor four printed copies of the Contract (including one fully signed counterpart of the Agreement), and one copy in electronic portable document format (PDF). Additional printed copies will be furnished upon request at the cost of reproduction.
- B. Owner shall maintain and safeguard at least one original printed record version of the Contract, including Drawings and Specifications signed and sealed by Engineer and other design professionals. Owner shall make such original printed record version of the Contract available to Contractor for review. Owner may delegate the responsibilities under this provision to Engineer.

2.03 *Before Starting Construction*

- A. *Preliminary Schedules*: Within 10 days after the Effective Date of the Contract (or as otherwise required by the Contract Documents), Contractor shall submit to Engineer for timely review:
 - 1. a preliminary Progress Schedule indicating the times (numbers of days or dates) for starting and completing the various stages of the Work, including any Milestones specified in the Contract;
 - 2. a preliminary Schedule of Submittals; and
 - 3. a preliminary Schedule of Values for all of the Work which includes quantities and prices of items which when added together equal the Contract Price and subdivides the Work

into component parts in sufficient detail to serve as the basis for progress payments during performance of the Work. Such prices will include an appropriate amount of overhead and profit applicable to each item of Work.

2.04 *Preconstruction Conference; Designation of Authorized Representatives*

- A. Before any Work at the Site is started, a conference attended by Owner, Contractor, Engineer, and others as appropriate will be held to establish a working understanding among the parties as to the Work, and to discuss the schedules referred to in Paragraph 2.03.A, procedures for handling Shop Drawings, Samples, and other Submittals, processing Applications for Payment, electronic or digital transmittals, and maintaining required records.
- B. At this conference Owner and Contractor each shall designate, in writing, a specific individual to act as its authorized representative with respect to the services and responsibilities under the Contract. Such individuals shall have the authority to transmit and receive information, render decisions relative to the Contract, and otherwise act on behalf of each respective party.

2.05 *Acceptance of Schedules*

- A. At least 10 days before submission of the first Application for Payment a conference, attended by Contractor, Engineer, and others as appropriate, will be held to review the schedules submitted in accordance with Paragraph 2.03.A. No progress payment will be made to Contractor until acceptable schedules are submitted to Engineer.
 - 1. The Progress Schedule will be acceptable to Engineer if it provides an orderly progression of the Work to completion within the Contract Times. Such acceptance will not impose on Engineer responsibility for the Progress Schedule, for sequencing, scheduling, or progress of the Work, nor interfere with or relieve Contractor from Contractor's full responsibility therefor.
 - 2. Contractor's Schedule of Submittals will be acceptable to Engineer if it provides a workable arrangement for reviewing and processing the required submittals.
 - 3. Contractor's Schedule of Values will be acceptable to Engineer as to form and substance if it provides a reasonable allocation of the Contract Price to the component parts of the Work.
 - 4. If a schedule is not acceptable, Contractor will have an additional 10 days to revise and resubmit the schedule.

2.06 *Electronic Transmittals*

- A. Except as otherwise stated elsewhere in the Contract, the Owner, Engineer, and Contractor may send, and shall accept, Electronic Documents transmitted by Electronic Means.
- B. If the Contract does not establish protocols for Electronic Means, then Owner, Engineer, and Contractor shall jointly develop such protocols.
- C. Subject to any governing protocols for Electronic Means, when transmitting Electronic Documents by Electronic Means, the transmitting party makes no representations as to long-term compatibility, usability, or readability of the Electronic Documents resulting from the recipient's use of software application packages, operating systems, or computer hardware differing from those used in the drafting or transmittal of the Electronic Documents.

ARTICLE 3—CONTRACT DOCUMENTS: INTENT, REQUIREMENTS, REUSE

3.01 *Intent*

- A. The Contract Documents are complementary; what is required by one Contract Document is as binding as if required by all.
- B. It is the intent of the Contract Documents to describe a functionally complete Project (or part thereof) to be constructed in accordance with the Contract Documents.
- C. Unless otherwise stated in the Contract Documents, if there is a discrepancy between the electronic versions of the Contract Documents (including any printed copies derived from such electronic versions) and the printed record version, the printed record version will govern.
- D. The Contract supersedes prior negotiations, representations, and agreements, whether written or oral.
- E. Engineer will issue clarifications and interpretations of the Contract Documents as provided herein.
- F. Any provision or part of the Contract Documents held to be void or unenforceable under any Law or Regulation will be deemed stricken, and all remaining provisions will continue to be valid and binding upon Owner and Contractor, which agree that the Contract Documents will be reformed to replace such stricken provision or part thereof with a valid and enforceable provision that comes as close as possible to expressing the intention of the stricken provision.
- G. Nothing in the Contract Documents creates:
 - 1. any contractual relationship between Owner or Engineer and any Subcontractor, Supplier, or other individual or entity performing or furnishing any of the Work, for the benefit of such Subcontractor, Supplier, or other individual or entity; or
 - 2. any obligation on the part of Owner or Engineer to pay or to see to the payment of any money due any such Subcontractor, Supplier, or other individual or entity, except as may otherwise be required by Laws and Regulations.

3.02 *Reference Standards*

- A. *Standards Specifications, Codes, Laws and Regulations*
 - 1. Reference in the Contract Documents to standard specifications, manuals, reference standards, or codes of any technical society, organization, or association, or to Laws or Regulations, whether such reference be specific or by implication, means the standard specification, manual, reference standard, code, or Laws or Regulations in effect at the time of opening of Bids (or on the Effective Date of the Contract if there were no Bids), except as may be otherwise specifically stated in the Contract Documents.
 - 2. No provision of any such standard specification, manual, reference standard, or code, and no instruction of a Supplier, will be effective to change the duties or responsibilities of Owner, Contractor, or Engineer from those set forth in the part of the Contract Documents prepared by or for Engineer. No such provision or instruction shall be effective to assign to Owner or Engineer any duty or authority to supervise or direct the performance of the Work, or any duty or authority to undertake responsibility

inconsistent with the provisions of the part of the Contract Documents prepared by or for Engineer.

3.03 *Reporting and Resolving Discrepancies*

A. *Reporting Discrepancies*

1. *Contractor's Verification of Figures and Field Measurements:* Before undertaking each part of the Work, Contractor shall carefully study the Contract Documents, and check and verify pertinent figures and dimensions therein, particularly with respect to applicable field measurements. Contractor shall promptly report in writing to Engineer any conflict, error, ambiguity, or discrepancy that Contractor discovers, or has actual knowledge of, and shall not proceed with any Work affected thereby until the conflict, error, ambiguity, or discrepancy is resolved by a clarification or interpretation by Engineer, or by an amendment or supplement to the Contract issued pursuant to Paragraph 11.01.
2. *Contractor's Review of Contract Documents:* If, before or during the performance of the Work, Contractor discovers any conflict, error, ambiguity, or discrepancy within the Contract Documents, or between the Contract Documents and (a) any applicable Law or Regulation, (b) actual field conditions, (c) any standard specification, manual, reference standard, or code, or (d) any instruction of any Supplier, then Contractor shall promptly report it to Engineer in writing. Contractor shall not proceed with the Work affected thereby (except in an emergency as required by Paragraph 7.15) until the conflict, error, ambiguity, or discrepancy is resolved, by a clarification or interpretation by Engineer, or by an amendment or supplement to the Contract issued pursuant to Paragraph 11.01.
3. Contractor shall not be liable to Owner or Engineer for failure to report any conflict, error, ambiguity, or discrepancy in the Contract Documents unless Contractor had actual knowledge thereof.

B. *Resolving Discrepancies*

1. Except as may be otherwise specifically stated in the Contract Documents, the provisions of the part of the Contract Documents prepared by or for Engineer take precedence in resolving any conflict, error, ambiguity, or discrepancy between such provisions of the Contract Documents and:
 - a. the provisions of any standard specification, manual, reference standard, or code, or the instruction of any Supplier (whether or not specifically incorporated by reference as a Contract Document); or
 - b. the provisions of any Laws or Regulations applicable to the performance of the Work (unless such an interpretation of the provisions of the Contract Documents would result in violation of such Law or Regulation).

3.04 *Requirements of the Contract Documents*

- A. During the performance of the Work and until final payment, Contractor and Owner shall submit to the Engineer in writing all matters in question concerning the requirements of the Contract Documents (sometimes referred to as requests for information or interpretation—RFIs), or relating to the acceptability of the Work under the Contract Documents, as soon as possible after such matters arise. Engineer will be the initial interpreter of the requirements of the Contract Documents, and judge of the acceptability of the Work.

- B. Engineer will, with reasonable promptness, render a written clarification, interpretation, or decision on the issue submitted, or initiate an amendment or supplement to the Contract Documents. Engineer's written clarification, interpretation, or decision will be final and binding on Contractor, unless it appeals by submitting a Change Proposal, and on Owner, unless it appeals by filing a Claim.
- C. If a submitted matter in question concerns terms and conditions of the Contract Documents that do not involve (1) the performance or acceptability of the Work under the Contract Documents, (2) the design (as set forth in the Drawings, Specifications, or otherwise), or (3) other engineering or technical matters, then Engineer will promptly notify Owner and Contractor in writing that Engineer is unable to provide a decision or interpretation. If Owner and Contractor are unable to agree on resolution of such a matter in question, either party may pursue resolution as provided in Article 12.

3.05 *Reuse of Documents*

- A. Contractor and its Subcontractors and Suppliers shall not:
 - 1. have or acquire any title to or ownership rights in any of the Drawings, Specifications, or other documents (or copies of any thereof) prepared by or bearing the seal of Engineer or its consultants, including electronic media versions, or reuse any such Drawings, Specifications, other documents, or copies thereof on extensions of the Project or any other project without written consent of Owner and Engineer and specific written verification or adaptation by Engineer; or
 - 2. have or acquire any title or ownership rights in any other Contract Documents, reuse any such Contract Documents for any purpose without Owner's express written consent, or violate any copyrights pertaining to such Contract Documents.
- B. The prohibitions of this Paragraph 3.05 will survive final payment, or termination of the Contract. Nothing herein precludes Contractor from retaining copies of the Contract Documents for record purposes.

ARTICLE 4—COMMENCEMENT AND PROGRESS OF THE WORK

4.01 *Commencement of Contract Times; Notice to Proceed*

- A. The Contract Times will commence to run on the 30th day after the Effective Date of the Contract or, if a Notice to Proceed is given, on the day indicated in the Notice to Proceed. A Notice to Proceed may be given at any time within 30 days after the Effective Date of the Contract. In no event will the Contract Times commence to run later than the 60th day after the day of Bid opening or the 30th day after the Effective Date of the Contract, whichever date is earlier.

4.02 *Starting the Work*

- A. Contractor shall start to perform the Work on the date when the Contract Times commence to run. No Work may be done at the Site prior to such date.

4.03 *Reference Points*

- A. Owner shall provide engineering surveys to establish reference points for construction which in Engineer's judgment are necessary to enable Contractor to proceed with the Work. Contractor shall be responsible for laying out the Work, shall protect and preserve the

established reference points and property monuments, and shall make no changes or relocations without the prior written approval of Owner. Contractor shall report to Engineer whenever any reference point or property monument is lost or destroyed or requires relocation because of necessary changes in grades or locations, and shall be responsible for the accurate replacement or relocation of such reference points or property monuments by professionally qualified personnel.

4.04 *Progress Schedule*

- A. Contractor shall adhere to the Progress Schedule established in accordance with Paragraph 2.05 as it may be adjusted from time to time as provided below.
 - 1. Contractor shall submit to Engineer for acceptance (to the extent indicated in Paragraph 2.05) proposed adjustments in the Progress Schedule that will not result in changing the Contract Times.
 - 2. Proposed adjustments in the Progress Schedule that will change the Contract Times must be submitted in accordance with the requirements of Article 11.
- B. Contractor shall carry on the Work and adhere to the Progress Schedule during all disputes or disagreements with Owner. No Work will be delayed or postponed pending resolution of any disputes or disagreements, or during any appeal process, except as permitted by Paragraph 16.04, or as Owner and Contractor may otherwise agree in writing.

4.05 *Delays in Contractor's Progress*

- A. If Owner, Engineer, or anyone for whom Owner is responsible, delays, disrupts, or interferes with the performance or progress of the Work, then Contractor shall be entitled to an equitable adjustment in Contract Price or Contract Times.
- B. Contractor shall not be entitled to an adjustment in Contract Price or Contract Times for delay, disruption, or interference caused by or within the control of Contractor. Delay, disruption, and interference attributable to and within the control of a Subcontractor or Supplier shall be deemed to be within the control of Contractor.
- C. If Contractor's performance or progress is delayed, disrupted, or interfered with by unanticipated causes not the fault of and beyond the control of Owner, Contractor, and those for which they are responsible, then Contractor shall be entitled to an equitable adjustment in Contract Times. Such an adjustment will be Contractor's sole and exclusive remedy for the delays, disruption, and interference described in this paragraph. Causes of delay, disruption, or interference that may give rise to an adjustment in Contract Times under this paragraph include but are not limited to the following:
 - 1. Severe and unavoidable natural catastrophes such as fires, floods, epidemics, and earthquakes;
 - 2. Abnormal weather conditions;
 - 3. Acts or failures to act of third-party utility owners or other third-party entities (other than those third-party utility owners or other third-party entities performing other work at or adjacent to the Site as arranged by or under contract with Owner, as contemplated in Article 8); and
 - 4. Acts of war or terrorism.

- D. Contractor's entitlement to an adjustment of Contract Times or Contract Price is limited as follows:
1. Contractor's entitlement to an adjustment of the Contract Times is conditioned on the delay, disruption, or interference adversely affecting an activity on the critical path to completion of the Work, as of the time of the delay, disruption, or interference.
 2. Contractor shall not be entitled to an adjustment in Contract Price for any delay, disruption, or interference if such delay is concurrent with a delay, disruption, or interference caused by or within the control of Contractor. Such a concurrent delay by Contractor shall not preclude an adjustment of Contract Times to which Contractor is otherwise entitled.
 3. Adjustments of Contract Times or Contract Price are subject to the provisions of Article 11.
- E. Each Contractor request or Change Proposal seeking an increase in Contract Times or Contract Price must be supplemented by supporting data that sets forth in detail the following:
1. The circumstances that form the basis for the requested adjustment;
 2. The date upon which each cause of delay, disruption, or interference began to affect the progress of the Work;
 3. The date upon which each cause of delay, disruption, or interference ceased to affect the progress of the Work;
 4. The number of days' increase in Contract Times claimed as a consequence of each such cause of delay, disruption, or interference; and
 5. The impact on Contract Price, in accordance with the provisions of Paragraph 11.07.
- Contractor shall also furnish such additional supporting documentation as Owner or Engineer may require including, where appropriate, a revised progress schedule indicating all the activities affected by the delay, disruption, or interference, and an explanation of the effect of the delay, disruption, or interference on the critical path to completion of the Work.
- F. Delays, disruption, and interference to the performance or progress of the Work resulting from the existence of a differing subsurface or physical condition, an Underground Facility that was not shown or indicated by the Contract Documents, or not shown or indicated with reasonable accuracy, and those resulting from Hazardous Environmental Conditions, are governed by Article 5, together with the provisions of Paragraphs 4.05.D and 4.05.E.
- G. Paragraph 8.03 addresses delays, disruption, and interference to the performance or progress of the Work resulting from the performance of certain other work at or adjacent to the Site.

ARTICLE 5—SITE; SUBSURFACE AND PHYSICAL CONDITIONS; HAZARDOUS ENVIRONMENTAL CONDITIONS

5.01 *Availability of Lands*

- A. Owner shall furnish the Site. Owner shall notify Contractor in writing of any encumbrances or restrictions not of general application but specifically related to use of the Site with which Contractor must comply in performing the Work.

- B. Upon reasonable written request, Owner shall furnish Contractor with a current statement of record legal title and legal description of the lands upon which permanent improvements are to be made and Owner's interest therein as necessary for giving notice of or filing a mechanic's or construction lien against such lands in accordance with applicable Laws and Regulations.
- C. Contractor shall provide for all additional lands and access thereto that may be required for temporary construction facilities or storage of materials and equipment.

5.02 *Use of Site and Other Areas*

A. *Limitation on Use of Site and Other Areas*

1. Contractor shall confine construction equipment, temporary construction facilities, the storage of materials and equipment, and the operations of workers to the Site, adjacent areas that Contractor has arranged to use through construction easements or otherwise, and other adjacent areas permitted by Laws and Regulations, and shall not unreasonably encumber the Site and such other adjacent areas with construction equipment or other materials or equipment. Contractor shall assume full responsibility for (a) damage to the Site; (b) damage to any such other adjacent areas used for Contractor's operations; (c) damage to any other adjacent land or areas, or to improvements, structures, utilities, or similar facilities located at such adjacent lands or areas; and (d) for injuries and losses sustained by the owners or occupants of any such land or areas; provided that such damage or injuries result from the performance of the Work or from other actions or conduct of the Contractor or those for which Contractor is responsible.
 2. If a damage or injury claim is made by the owner or occupant of any such land or area because of the performance of the Work, or because of other actions or conduct of the Contractor or those for which Contractor is responsible, Contractor shall (a) take immediate corrective or remedial action as required by Paragraph 7.13, or otherwise; (b) promptly attempt to settle the claim as to all parties through negotiations with such owner or occupant, or otherwise resolve the claim by arbitration or other dispute resolution proceeding, or in a court of competent jurisdiction; and (c) to the fullest extent permitted by Laws and Regulations, indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them, from and against any such claim, and against all costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to any claim or action, legal or equitable, brought by any such owner or occupant against Owner, Engineer, or any other party indemnified hereunder to the extent caused directly or indirectly, in whole or in part by, or based upon, Contractor's performance of the Work, or because of other actions or conduct of the Contractor or those for which Contractor is responsible.
- B. *Removal of Debris During Performance of the Work:* During the progress of the Work the Contractor shall keep the Site and other adjacent areas free from accumulations of waste materials, rubbish, and other debris. Removal and disposal of such waste materials, rubbish, and other debris will conform to applicable Laws and Regulations.
 - C. *Cleaning:* Prior to Substantial Completion of the Work Contractor shall clean the Site and the Work and make it ready for utilization by Owner. At the completion of the Work Contractor shall remove from the Site and adjacent areas all tools, appliances, construction equipment

and machinery, and surplus materials and shall restore to original condition all property not designated for alteration by the Contract Documents.

- D. *Loading of Structures:* Contractor shall not load nor permit any part of any structure to be loaded in any manner that will endanger the structure, nor shall Contractor subject any part of the Work or adjacent structures or land to stresses or pressures that will endanger them.

5.03 *Subsurface and Physical Conditions*

- A. *Reports and Drawings:* The Supplementary Conditions identify:

1. Those reports of explorations and tests of subsurface conditions at or adjacent to the Site that contain Technical Data;
2. Those drawings of existing physical conditions at or adjacent to the Site, including those drawings depicting existing surface or subsurface structures at or adjacent to the Site (except Underground Facilities), that contain Technical Data; and
3. Technical Data contained in such reports and drawings.

- B. *Underground Facilities:* Underground Facilities are shown or indicated on the Drawings, pursuant to Paragraph 5.05, and not in the drawings referred to in Paragraph 5.03.A. Information and data regarding the presence or location of Underground Facilities are not intended to be categorized, identified, or defined as Technical Data.

- C. *Reliance by Contractor on Technical Data:* Contractor may rely upon the accuracy of the Technical Data expressly identified in the Supplementary Conditions with respect to such reports and drawings, but such reports and drawings are not Contract Documents. If no such express identification has been made, then Contractor may rely upon the accuracy of the Technical Data as defined in Paragraph 1.01.A.46.b.

- D. *Limitations of Other Data and Documents:* Except for such reliance on Technical Data, Contractor may not rely upon or make any claim against Owner or Engineer, or any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors, with respect to:

1. the completeness of such reports and drawings for Contractor's purposes, including, but not limited to, any aspects of the means, methods, techniques, sequences, and procedures of construction to be employed by Contractor, and safety precautions and programs incident thereto;
2. other data, interpretations, opinions, and information contained in such reports or shown or indicated in such drawings;
3. the contents of other Site-related documents made available to Contractor, such as record drawings from other projects at or adjacent to the Site, or Owner's archival documents concerning the Site; or
4. any Contractor interpretation of or conclusion drawn from any Technical Data or any such other data, interpretations, opinions, or information.

5.04 *Differing Subsurface or Physical Conditions*

- A. *Notice by Contractor:* If Contractor believes that any subsurface or physical condition that is uncovered or revealed at the Site:
1. is of such a nature as to establish that any Technical Data on which Contractor is entitled to rely as provided in Paragraph 5.03 is materially inaccurate;
 2. is of such a nature as to require a change in the Drawings or Specifications;
 3. differs materially from that shown or indicated in the Contract Documents; or
 4. is of an unusual nature, and differs materially from conditions ordinarily encountered and generally recognized as inherent in work of the character provided for in the Contract Documents;

then Contractor shall, promptly after becoming aware thereof and before further disturbing the subsurface or physical conditions or performing any Work in connection therewith (except in an emergency as required by Paragraph 7.15), notify Owner and Engineer in writing about such condition. Contractor shall not further disturb such condition or perform any Work in connection therewith (except with respect to an emergency) until receipt of a written statement permitting Contractor to do so.

- B. *Engineer's Review:* After receipt of written notice as required by the preceding paragraph, Engineer will promptly review the subsurface or physical condition in question; determine whether it is necessary for Owner to obtain additional exploration or tests with respect to the condition; conclude whether the condition falls within any one or more of the differing site condition categories in Paragraph 5.04.A; obtain any pertinent cost or schedule information from Contractor; prepare recommendations to Owner regarding the Contractor's resumption of Work in connection with the subsurface or physical condition in question and the need for any change in the Drawings or Specifications; and advise Owner in writing of Engineer's findings, conclusions, and recommendations.
- C. *Owner's Statement to Contractor Regarding Site Condition:* After receipt of Engineer's written findings, conclusions, and recommendations, Owner shall issue a written statement to Contractor (with a copy to Engineer) regarding the subsurface or physical condition in question, addressing the resumption of Work in connection with such condition, indicating whether any change in the Drawings or Specifications will be made, and adopting or rejecting Engineer's written findings, conclusions, and recommendations, in whole or in part.
- D. *Early Resumption of Work:* If at any time Engineer determines that Work in connection with the subsurface or physical condition in question may resume prior to completion of Engineer's review or Owner's issuance of its statement to Contractor, because the condition in question has been adequately documented, and analyzed on a preliminary basis, then the Engineer may at its discretion instruct Contractor to resume such Work.
- E. *Possible Price and Times Adjustments*
1. Contractor shall be entitled to an equitable adjustment in Contract Price or Contract Times, to the extent that the existence of a differing subsurface or physical condition, or any related delay, disruption, or interference, causes an increase or decrease in

Contractor's cost of, or time required for, performance of the Work; subject, however, to the following:

- a. Such condition must fall within any one or more of the categories described in Paragraph 5.04.A;
 - b. With respect to Work that is paid for on a unit price basis, any adjustment in Contract Price will be subject to the provisions of Paragraph 13.03; and,
 - c. Contractor's entitlement to an adjustment of the Contract Times is subject to the provisions of Paragraphs 4.05.D and 4.05.E.
2. Contractor shall not be entitled to any adjustment in the Contract Price or Contract Times with respect to a subsurface or physical condition if:
- a. Contractor knew of the existence of such condition at the time Contractor made a commitment to Owner with respect to Contract Price and Contract Times by the submission of a Bid or becoming bound under a negotiated contract, or otherwise;
 - b. The existence of such condition reasonably could have been discovered or revealed as a result of any examination, investigation, exploration, test, or study of the Site and contiguous areas expressly required by the Bidding Requirements or Contract Documents to be conducted by or for Contractor prior to Contractor's making such commitment; or
 - c. Contractor failed to give the written notice required by Paragraph 5.04.A.
3. If Owner and Contractor agree regarding Contractor's entitlement to and the amount or extent of any adjustment in the Contract Price or Contract Times, then any such adjustment will be set forth in a Change Order.
4. Contractor may submit a Change Proposal regarding its entitlement to or the amount or extent of any adjustment in the Contract Price or Contract Times, no later than 30 days after Owner's issuance of the Owner's written statement to Contractor regarding the subsurface or physical condition in question.
- F. *Underground Facilities; Hazardous Environmental Conditions*: Paragraph 5.05 governs rights and responsibilities regarding the presence or location of Underground Facilities. Paragraph 5.06 governs rights and responsibilities regarding Hazardous Environmental Conditions. The provisions of Paragraphs 5.03 and 5.04 are not applicable to the presence or location of Underground Facilities, or to Hazardous Environmental Conditions.

5.05 *Underground Facilities*

- A. *Contractor's Responsibilities*: Unless it is otherwise expressly provided in the Supplementary Conditions, the cost of all of the following are included in the Contract Price, and Contractor shall have full responsibility for:
1. reviewing and checking all information and data regarding existing Underground Facilities at the Site;
 2. complying with applicable state and local utility damage prevention Laws and Regulations;

3. verifying the actual location of those Underground Facilities shown or indicated in the Contract Documents as being within the area affected by the Work, by exposing such Underground Facilities during the course of construction;
 4. coordination of the Work with the owners (including Owner) of such Underground Facilities, during construction; and
 5. the safety and protection of all existing Underground Facilities at the Site, and repairing any damage thereto resulting from the Work.
- B. *Notice by Contractor:* If Contractor believes that an Underground Facility that is uncovered or revealed at the Site was not shown or indicated on the Drawings, or was not shown or indicated on the Drawings with reasonable accuracy, then Contractor shall, promptly after becoming aware thereof and before further disturbing conditions affected thereby or performing any Work in connection therewith (except in an emergency as required by Paragraph 7.15), notify Owner and Engineer in writing regarding such Underground Facility.
- C. *Engineer's Review:* Engineer will:
1. promptly review the Underground Facility and conclude whether such Underground Facility was not shown or indicated on the Drawings, or was not shown or indicated with reasonable accuracy;
 2. identify and communicate with the owner of the Underground Facility; prepare recommendations to Owner (and if necessary issue any preliminary instructions to Contractor) regarding the Contractor's resumption of Work in connection with the Underground Facility in question;
 3. obtain any pertinent cost or schedule information from Contractor; determine the extent, if any, to which a change is required in the Drawings or Specifications to reflect and document the consequences of the existence or location of the Underground Facility; and
 4. advise Owner in writing of Engineer's findings, conclusions, and recommendations.

During such time, Contractor shall be responsible for the safety and protection of such Underground Facility.

- D. *Owner's Statement to Contractor Regarding Underground Facility:* After receipt of Engineer's written findings, conclusions, and recommendations, Owner shall issue a written statement to Contractor (with a copy to Engineer) regarding the Underground Facility in question addressing the resumption of Work in connection with such Underground Facility, indicating whether any change in the Drawings or Specifications will be made, and adopting or rejecting Engineer's written findings, conclusions, and recommendations in whole or in part.
- E. *Early Resumption of Work:* If at any time Engineer determines that Work in connection with the Underground Facility may resume prior to completion of Engineer's review or Owner's issuance of its statement to Contractor, because the Underground Facility in question and conditions affected by its presence have been adequately documented, and analyzed on a preliminary basis, then the Engineer may at its discretion instruct Contractor to resume such Work.
- F. *Possible Price and Times Adjustments*
1. Contractor shall be entitled to an equitable adjustment in the Contract Price or Contract Times, to the extent that any existing Underground Facility at the Site that was not shown

or indicated on the Drawings, or was not shown or indicated with reasonable accuracy, or any related delay, disruption, or interference, causes an increase or decrease in Contractor's cost of, or time required for, performance of the Work; subject, however, to the following:

- a. With respect to Work that is paid for on a unit price basis, any adjustment in Contract Price will be subject to the provisions of Paragraph 13.03;
 - b. Contractor's entitlement to an adjustment of the Contract Times is subject to the provisions of Paragraphs 4.05.D and 4.05.E; and
 - c. Contractor gave the notice required in Paragraph 5.05.B.
2. If Owner and Contractor agree regarding Contractor's entitlement to and the amount or extent of any adjustment in the Contract Price or Contract Times, then any such adjustment will be set forth in a Change Order.
 3. Contractor may submit a Change Proposal regarding its entitlement to or the amount or extent of any adjustment in the Contract Price or Contract Times, no later than 30 days after Owner's issuance of the Owner's written statement to Contractor regarding the Underground Facility in question.
 4. The information and data shown or indicated on the Drawings with respect to existing Underground Facilities at the Site is based on information and data (a) furnished by the owners of such Underground Facilities, or by others, (b) obtained from available records, or (c) gathered in an investigation conducted in accordance with the current edition of ASCE 38, Standard Guideline for the Collection and Depiction of Existing Subsurface Utility Data, by the American Society of Civil Engineers. If such information or data is incorrect or incomplete, Contractor's remedies are limited to those set forth in this Paragraph 5.05.F.

5.06 *Hazardous Environmental Conditions at Site*

A. *Reports and Drawings:* The Supplementary Conditions identify:

1. those reports known to Owner relating to Hazardous Environmental Conditions that have been identified at or adjacent to the Site;
2. drawings known to Owner relating to Hazardous Environmental Conditions that have been identified at or adjacent to the Site; and
3. Technical Data contained in such reports and drawings.

B. *Reliance by Contractor on Technical Data Authorized:* Contractor may rely upon the accuracy of the Technical Data expressly identified in the Supplementary Conditions with respect to such reports and drawings, but such reports and drawings are not Contract Documents. If no such express identification has been made, then Contractor may rely on the accuracy of the Technical Data as defined in Paragraph 1.01.A.46.b. Except for such reliance on Technical Data, Contractor may not rely upon or make any claim against Owner or Engineer, or any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors, with respect to:

1. the completeness of such reports and drawings for Contractor's purposes, including, but not limited to, any aspects of the means, methods, techniques, sequences and procedures

- of construction to be employed by Contractor, and safety precautions and programs incident thereto;
2. other data, interpretations, opinions, and information contained in such reports or shown or indicated in such drawings; or
 3. any Contractor interpretation of or conclusion drawn from any Technical Data or any such other data, interpretations, opinions or information.
- C. Contractor shall not be responsible for removing or remediating any Hazardous Environmental Condition encountered, uncovered, or revealed at the Site unless such removal or remediation is expressly identified in the Contract Documents to be within the scope of the Work.
- D. Contractor shall be responsible for controlling, containing, and duly removing all Constituents of Concern brought to the Site by Contractor, Subcontractors, Suppliers, or anyone else for whom Contractor is responsible, and for any associated costs; and for the costs of removing and remediating any Hazardous Environmental Condition created by the presence of any such Constituents of Concern.
- E. If Contractor encounters, uncovers, or reveals a Hazardous Environmental Condition whose removal or remediation is not expressly identified in the Contract Documents as being within the scope of the Work, or if Contractor or anyone for whom Contractor is responsible creates a Hazardous Environmental Condition, then Contractor shall immediately: (1) secure or otherwise isolate such condition; (2) stop all Work in connection with such condition and in any area affected thereby (except in an emergency as required by Paragraph 7.15); and (3) notify Owner and Engineer (and promptly thereafter confirm such notice in writing). Owner shall promptly consult with Engineer concerning the necessity for Owner to retain a qualified expert to evaluate such condition or take corrective action, if any. Promptly after consulting with Engineer, Owner shall take such actions as are necessary to permit Owner to timely obtain required permits and provide Contractor the written notice required by Paragraph 5.06.F. If Contractor or anyone for whom Contractor is responsible created the Hazardous Environmental Condition in question, then Owner may remove and remediate the Hazardous Environmental Condition, and impose a set-off against payments to account for the associated costs.
- F. Contractor shall not resume Work in connection with such Hazardous Environmental Condition or in any affected area until after Owner has obtained any required permits related thereto, and delivered written notice to Contractor either (1) specifying that such condition and any affected area is or has been rendered safe for the resumption of Work, or (2) specifying any special conditions under which such Work may be resumed safely.
- G. If Owner and Contractor cannot agree as to entitlement to or on the amount or extent, if any, of any adjustment in Contract Price or Contract Times, as a result of such Work stoppage, such special conditions under which Work is agreed to be resumed by Contractor, or any costs or expenses incurred in response to the Hazardous Environmental Condition, then within 30 days of Owner's written notice regarding the resumption of Work, Contractor may submit a Change Proposal, or Owner may impose a set-off. Entitlement to any such adjustment is subject to the provisions of Paragraphs 4.05.D, 4.05.E, 11.07, and 11.08.
- H. If, after receipt of such written notice, Contractor does not agree to resume such Work based on a reasonable belief it is unsafe, or does not agree to resume such Work under such special

conditions, then Owner may order the portion of the Work that is in the area affected by such condition to be deleted from the Work, following the contractual change procedures in Article 11. Owner may have such deleted portion of the Work performed by Owner's own forces or others in accordance with Article 8.

- I. To the fullest extent permitted by Laws and Regulations, Owner shall indemnify and hold harmless Contractor, Subcontractors, and Engineer, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them, from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals, and all court, arbitration, or other dispute resolution costs) arising out of or relating to a Hazardous Environmental Condition, provided that such Hazardous Environmental Condition (1) was not shown or indicated in the Drawings, Specifications, or other Contract Documents, identified as Technical Data entitled to limited reliance pursuant to Paragraph 5.06.B, or identified in the Contract Documents to be included within the scope of the Work, and (2) was not created by Contractor or by anyone for whom Contractor is responsible. Nothing in this Paragraph 5.06.I obligates Owner to indemnify any individual or entity from and against the consequences of that individual's or entity's own negligence.
- J. To the fullest extent permitted by Laws and Regulations, Contractor shall indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them, from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to the failure to control, contain, or remove a Constituent of Concern brought to the Site by Contractor or by anyone for whom Contractor is responsible, or to a Hazardous Environmental Condition created by Contractor or by anyone for whom Contractor is responsible. Nothing in this Paragraph 5.06.J obligates Contractor to indemnify any individual or entity from and against the consequences of that individual's or entity's own negligence.
- K. The provisions of Paragraphs 5.03, 5.04, and 5.05 do not apply to the presence of Constituents of Concern or to a Hazardous Environmental Condition uncovered or revealed at the Site.

ARTICLE 6—BONDS AND INSURANCE

6.01 *Performance, Payment, and Other Bonds*

- A. Contractor shall furnish a performance bond and a payment bond, each in an amount at least equal to the Contract Price, as security for the faithful performance and payment of Contractor's obligations under the Contract. These bonds must remain in effect until one year after the date when final payment becomes due or until completion of the correction period specified in Paragraph 15.08, whichever is later, except as provided otherwise by Laws or Regulations, the terms of a prescribed bond form, the Supplementary Conditions, or other provisions of the Contract.
- B. Contractor shall also furnish such other bonds (if any) as are required by the Supplementary Conditions or other provisions of the Contract.
- C. All bonds must be in the form included in the Bidding Documents or otherwise specified by Owner prior to execution of the Contract, except as provided otherwise by Laws or

Regulations, and must be issued and signed by a surety named in “Companies Holding Certificates of Authority as Acceptable Sureties on Federal Bonds and as Acceptable Reinsuring Companies” as published in Department Circular 570 (as amended and supplemented) by the Bureau of the Fiscal Service, U.S. Department of the Treasury. A bond signed by an agent or attorney-in-fact must be accompanied by a certified copy of that individual’s authority to bind the surety. The evidence of authority must show that it is effective on the date the agent or attorney-in-fact signed the accompanying bond.

- D. Contractor shall obtain the required bonds from surety companies that are duly licensed or authorized, in the state or jurisdiction in which the Project is located, to issue bonds in the required amounts.
- E. If the surety on a bond furnished by Contractor is declared bankrupt or becomes insolvent, or the surety ceases to meet the requirements above, then Contractor shall promptly notify Owner and Engineer in writing and shall, within 20 days after the event giving rise to such notification, provide another bond and surety, both of which must comply with the bond and surety requirements above.
- F. If Contractor has failed to obtain a required bond, Owner may exclude the Contractor from the Site and exercise Owner’s termination rights under Article 16.
- G. Upon request to Owner from any Subcontractor, Supplier, or other person or entity claiming to have furnished labor, services, materials, or equipment used in the performance of the Work, Owner shall provide a copy of the payment bond to such person or entity.
- H. Upon request to Contractor from any Subcontractor, Supplier, or other person or entity claiming to have furnished labor, services, materials, or equipment used in the performance of the Work, Contractor shall provide a copy of the payment bond to such person or entity.

6.02 *Insurance—General Provisions*

- A. Owner and Contractor shall obtain and maintain insurance as required in this article and in the Supplementary Conditions.
- B. All insurance required by the Contract to be purchased and maintained by Owner or Contractor shall be obtained from insurance companies that are duly licensed or authorized in the state or jurisdiction in which the Project is located to issue insurance policies for the required limits and coverages. Unless a different standard is indicated in the Supplementary Conditions, all companies that provide insurance policies required under this Contract shall have an A.M. Best rating of A-VII or better.
- C. Alternative forms of insurance coverage, including but not limited to self-insurance and “Occupational Accident and Excess Employer’s Indemnity Policies,” are not sufficient to meet the insurance requirements of this Contract, unless expressly allowed in the Supplementary Conditions.
- D. Contractor shall deliver to Owner, with copies to each additional insured identified in the Contract, certificates of insurance and endorsements establishing that Contractor has obtained and is maintaining the policies and coverages required by the Contract. Upon request by Owner or any other insured, Contractor shall also furnish other evidence of such required insurance, including but not limited to copies of policies, documentation of applicable self-insured retentions (if allowed) and deductibles, full disclosure of all relevant exclusions, and evidence of insurance required to be purchased and maintained by

Subcontractors or Suppliers. In any documentation furnished under this provision, Contractor, Subcontractors, and Suppliers may block out (redact) (1) any confidential premium or pricing information and (2) any wording specific to a project or jurisdiction other than those applicable to this Contract.

- E. Owner shall deliver to Contractor, with copies to each additional insured identified in the Contract, certificates of insurance and endorsements establishing that Owner has obtained and is maintaining the policies and coverages required of Owner by the Contract (if any). Upon request by Contractor or any other insured, Owner shall also provide other evidence of such required insurance (if any), including but not limited to copies of policies, documentation of applicable self-insured retentions (if allowed) and deductibles, and full disclosure of all relevant exclusions. In any documentation furnished under this provision, Owner may block out (redact) (1) any confidential premium or pricing information and (2) any wording specific to a project or jurisdiction other than those relevant to this Contract.
- F. Failure of Owner or Contractor to demand such certificates or other evidence of the other party's full compliance with these insurance requirements, or failure of Owner or Contractor to identify a deficiency in compliance from the evidence provided, will not be construed as a waiver of the other party's obligation to obtain and maintain such insurance.
- G. In addition to the liability insurance required to be provided by Contractor, the Owner, at Owner's option, may purchase and maintain Owner's own liability insurance. Owner's liability policies, if any, operate separately and independently from policies required to be provided by Contractor, and Contractor cannot rely upon Owner's liability policies for any of Contractor's obligations to the Owner, Engineer, or third parties.
- H. Contractor shall require:
 - 1. Subcontractors to purchase and maintain worker's compensation, commercial general liability, and other insurance that is appropriate for their participation in the Project, and to name as additional insureds Owner and Engineer (and any other individuals or entities identified in the Supplementary Conditions as additional insureds on Contractor's liability policies) on each Subcontractor's commercial general liability insurance policy; and
 - 2. Suppliers to purchase and maintain insurance that is appropriate for their participation in the Project.
- I. If either party does not purchase or maintain the insurance required of such party by the Contract, such party shall notify the other party in writing of such failure to purchase prior to the start of the Work, or of such failure to maintain prior to any change in the required coverage.
- J. If Contractor has failed to obtain and maintain required insurance, Contractor's entitlement to enter or remain at the Site will end immediately, and Owner may impose an appropriate set-off against payment for any associated costs (including but not limited to the cost of purchasing necessary insurance coverage), and exercise Owner's termination rights under Article 16.
- K. Without prejudice to any other right or remedy, if a party has failed to obtain required insurance, the other party may elect (but is in no way obligated) to obtain equivalent insurance to protect such other party's interests at the expense of the party who was required to provide such coverage, and the Contract Price will be adjusted accordingly.

- L. Owner does not represent that insurance coverage and limits established in this Contract necessarily will be adequate to protect Contractor or Contractor's interests. Contractor is responsible for determining whether such coverage and limits are adequate to protect its interests, and for obtaining and maintaining any additional insurance that Contractor deems necessary.
- M. The insurance and insurance limits required herein will not be deemed as a limitation on Contractor's liability, or that of its Subcontractors or Suppliers, under the indemnities granted to Owner and other individuals and entities in the Contract or otherwise.
- N. All the policies of insurance required to be purchased and maintained under this Contract will contain a provision or endorsement that the coverage afforded will not be canceled, or renewal refused, until at least 10 days prior written notice has been given to the purchasing policyholder. Within three days of receipt of any such written notice, the purchasing policyholder shall provide a copy of the notice to each other insured and Engineer.

6.03 *Contractor's Insurance*

- A. *Required Insurance:* Contractor shall purchase and maintain Worker's Compensation, Commercial General Liability, and other insurance pursuant to the specific requirements of the Supplementary Conditions.
- B. *General Provisions:* The policies of insurance required by this Paragraph 6.03 as supplemented must:
 - 1. include at least the specific coverages required;
 - 2. be written for not less than the limits provided, or those required by Laws or Regulations, whichever is greater;
 - 3. remain in effect at least until the Work is complete (as set forth in Paragraph 15.06.D), and longer if expressly required elsewhere in this Contract, and at all times thereafter when Contractor may be correcting, removing, or replacing defective Work as a warranty or correction obligation, or otherwise, or returning to the Site to conduct other tasks arising from the Contract;
 - 4. apply with respect to the performance of the Work, whether such performance is by Contractor, any Subcontractor or Supplier, or by anyone directly or indirectly employed by any of them to perform any of the Work, or by anyone for whose acts any of them may be liable; and
 - 5. include all necessary endorsements to support the stated requirements.
- C. *Additional Insureds:* The Contractor's commercial general liability, automobile liability, employer's liability, umbrella or excess, pollution liability, and unmanned aerial vehicle liability policies, if required by this Contract, must:
 - 1. include and list as additional insureds Owner and Engineer, and any individuals or entities identified as additional insureds in the Supplementary Conditions;
 - 2. include coverage for the respective officers, directors, members, partners, employees, and consultants of all such additional insureds;
 - 3. afford primary coverage to these additional insureds for all claims covered thereby (including as applicable those arising from both ongoing and completed operations);

4. not seek contribution from insurance maintained by the additional insured; and
5. as to commercial general liability insurance, apply to additional insureds with respect to liability caused in whole or in part by Contractor's acts or omissions, or the acts and omissions of those working on Contractor's behalf, in the performance of Contractor's operations.

6.04 *Builder's Risk and Other Property Insurance*

- A. *Builder's Risk*: Unless otherwise provided in the Supplementary Conditions, Contractor shall purchase and maintain builder's risk insurance upon the Work on a completed value basis, in the amount of the Work's full insurable replacement cost (subject to such deductible amounts as may be provided in the Supplementary Conditions or required by Laws and Regulations). The specific requirements applicable to the builder's risk insurance are set forth in the Supplementary Conditions.
- B. *Property Insurance for Facilities of Owner Where Work Will Occur*: Owner is responsible for obtaining and maintaining property insurance covering each existing structure, building, or facility in which any part of the Work will occur, or to which any part of the Work will attach or be adjoined. Such property insurance will be written on a special perils (all-risk) form, on a replacement cost basis, providing coverage consistent with that required for the builder's risk insurance, and will be maintained until the Work is complete, as set forth in Paragraph 15.06.D.
- C. *Property Insurance for Substantially Complete Facilities*: Promptly after Substantial Completion, and before actual occupancy or use of the substantially completed Work, Owner will obtain property insurance for such substantially completed Work, and maintain such property insurance at least until the Work is complete, as set forth in Paragraph 15.06.D. Such property insurance will be written on a special perils (all-risk) form, on a replacement cost basis, and provide coverage consistent with that required for the builder's risk insurance. The builder's risk insurance may terminate upon written confirmation of Owner's procurement of such property insurance.
- D. *Partial Occupancy or Use by Owner*: If Owner will occupy or use a portion or portions of the Work prior to Substantial Completion of all the Work, as provided in Paragraph 15.04, then Owner (directly, if it is the purchaser of the builder's risk policy, or through Contractor) will provide advance notice of such occupancy or use to the builder's risk insurer, and obtain an endorsement consenting to the continuation of coverage prior to commencing such partial occupancy or use.
- E. *Insurance of Other Property; Additional Insurance*: If the express insurance provisions of the Contract do not require or address the insurance of a property item or interest, then the entity or individual owning such property item will be responsible for insuring it. If Contractor elects to obtain other special insurance to be included in or supplement the builder's risk or property insurance policies provided under this Paragraph 6.04, it may do so at Contractor's expense.

6.05 *Property Losses; Subrogation*

- A. The builder's risk insurance policy purchased and maintained in accordance with Paragraph 6.04 (or an installation floater policy if authorized by the Supplementary Conditions), will contain provisions to the effect that in the event of payment of any loss or damage the insurer will have no rights of recovery against any insureds thereunder, or against

Engineer or its consultants, or their officers, directors, members, partners, employees, agents, consultants, or subcontractors.

1. Owner and Contractor waive all rights against each other and the respective officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them, for all losses and damages caused by, arising out of, or resulting from any of the perils, risks, or causes of loss covered by such policies and any other property insurance applicable to the Work; and, in addition, waive all such rights against Engineer, its consultants, all individuals or entities identified in the Supplementary Conditions as builder's risk or installation floater insureds, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them, under such policies for losses and damages so caused.
 2. None of the above waivers extends to the rights that any party making such waiver may have to the proceeds of insurance held by Owner or Contractor as trustee or fiduciary, or otherwise payable under any policy so issued.
- B. Any property insurance policy maintained by Owner covering any loss, damage, or consequential loss to Owner's existing structures, buildings, or facilities in which any part of the Work will occur, or to which any part of the Work will attach or adjoin; to adjacent structures, buildings, or facilities of Owner; or to part or all of the completed or substantially completed Work, during partial occupancy or use pursuant to Paragraph 15.04, after Substantial Completion pursuant to Paragraph 15.03, or after final payment pursuant to Paragraph 15.06, will contain provisions to the effect that in the event of payment of any loss or damage the insurer will have no rights of recovery against any insureds thereunder, or against Contractor, Subcontractors, or Engineer, or the officers, directors, members, partners, employees, agents, consultants, or subcontractors of each and any of them, and that the insured is allowed to waive the insurer's rights of subrogation in a written contract executed prior to the loss, damage, or consequential loss.
1. Owner waives all rights against Contractor, Subcontractors, and Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them, for all losses and damages caused by, arising out of, or resulting from fire or any of the perils, risks, or causes of loss covered by such policies.
- C. The waivers in this Paragraph 6.05 include the waiver of rights due to business interruption, loss of use, or other consequential loss extending beyond direct physical loss or damage to Owner's property or the Work caused by, arising out of, or resulting from fire or other insured peril, risk, or cause of loss.
- D. Contractor shall be responsible for assuring that each Subcontract contains provisions whereby the Subcontractor waives all rights against Owner, Contractor, all individuals or entities identified in the Supplementary Conditions as insureds, the Engineer and its consultants, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them, for all losses and damages caused by, arising out of, relating to, or resulting from fire or other peril, risk, or cause of loss covered by builder's risk insurance, installation floater, and any other property insurance applicable to the Work.

6.06 *Receipt and Application of Property Insurance Proceeds*

- A. Any insured loss under the builder's risk and other policies of property insurance required by Paragraph 6.04 will be adjusted and settled with the named insured that purchased the policy. Such named insured shall act as fiduciary for the other insureds, and give notice to such other insureds that adjustment and settlement of a claim is in progress. Any other insured may state its position regarding a claim for insured loss in writing within 15 days after notice of such claim.
- B. Proceeds for such insured losses may be made payable by the insurer either jointly to multiple insureds, or to the named insured that purchased the policy in its own right and as fiduciary for other insureds, subject to the requirements of any applicable mortgage clause. A named insured receiving insurance proceeds under the builder's risk and other policies of insurance required by Paragraph 6.04 shall maintain such proceeds in a segregated account, and distribute such proceeds in accordance with such agreement as the parties in interest may reach, or as otherwise required under the dispute resolution provisions of this Contract or applicable Laws and Regulations.
- C. If no other special agreement is reached, Contractor shall repair or replace the damaged Work, using allocated insurance proceeds.

ARTICLE 7—CONTRACTOR'S RESPONSIBILITIES

7.01 *Contractor's Means and Methods of Construction*

- A. Contractor shall be solely responsible for the means, methods, techniques, sequences, and procedures of construction.
- B. If the Contract Documents note, or Contractor determines, that professional engineering or other design services are needed to carry out Contractor's responsibilities for construction means, methods, techniques, sequences, and procedures, or for Site safety, then Contractor shall cause such services to be provided by a properly licensed design professional, at Contractor's expense. Such services are not Owner-delegated professional design services under this Contract, and neither Owner nor Engineer has any responsibility with respect to (1) Contractor's determination of the need for such services, (2) the qualifications or licensing of the design professionals retained or employed by Contractor, (3) the performance of such services, or (4) any errors, omissions, or defects in such services.

7.02 *Supervision and Superintendence*

- A. Contractor shall supervise, inspect, and direct the Work competently and efficiently, devoting such attention thereto and applying such skills and expertise as may be necessary to perform the Work in accordance with the Contract Documents.
- B. At all times during the progress of the Work, Contractor shall assign a competent resident superintendent who will not be replaced without written notice to Owner and Engineer except under extraordinary circumstances.

7.03 *Labor; Working Hours*

- A. Contractor shall provide competent, suitably qualified personnel to survey and lay out the Work and perform construction as required by the Contract Documents. Contractor shall maintain good discipline and order at the Site.

- B. Contractor shall be fully responsible to Owner and Engineer for all acts and omissions of Contractor's employees; of Suppliers and Subcontractors, and their employees; and of any other individuals or entities performing or furnishing any of the Work, just as Contractor is responsible for Contractor's own acts and omissions.
- C. Except as otherwise required for the safety or protection of persons or the Work or property at the Site or adjacent thereto, and except as otherwise stated in the Contract Documents, all Work at the Site will be performed during regular working hours, Monday through Friday. Contractor will not perform Work on a Saturday, Sunday, or any legal holiday. Contractor may perform Work outside regular working hours or on Saturdays, Sundays, or legal holidays only with Owner's written consent, which will not be unreasonably withheld.

7.04 *Services, Materials, and Equipment*

- A. Unless otherwise specified in the Contract Documents, Contractor shall provide and assume full responsibility for all services, materials, equipment, labor, transportation, construction equipment and machinery, tools, appliances, fuel, power, light, heat, telephone, water, sanitary facilities, temporary facilities, and all other facilities and incidentals necessary for the performance, testing, start up, and completion of the Work, whether or not such items are specifically called for in the Contract Documents.
- B. All materials and equipment incorporated into the Work must be new and of good quality, except as otherwise provided in the Contract Documents. All special warranties and guarantees required by the Specifications will expressly run to the benefit of Owner. If required by Engineer, Contractor shall furnish satisfactory evidence (including reports of required tests) as to the source, kind, and quality of materials and equipment.
- C. All materials and equipment must be stored, applied, installed, connected, erected, protected, used, cleaned, and conditioned in accordance with instructions of the applicable Supplier, except as otherwise may be provided in the Contract Documents.

7.05 *"Or Equals"*

- A. *Contractor's Request; Governing Criteria:* Whenever an item of equipment or material is specified or described in the Contract Documents by using the names of one or more proprietary items or specific Suppliers, the Contract Price has been based upon Contractor furnishing such item as specified. The specification or description of such an item is intended to establish the type, function, appearance, and quality required. Unless the specification or description contains or is followed by words reading that no like, equivalent, or "or equal" item is permitted, Contractor may request that Engineer authorize the use of other items of equipment or material, or items from other proposed Suppliers, under the circumstances described below.
 - 1. If Engineer in its sole discretion determines that an item of equipment or material proposed by Contractor is functionally equal to that named and sufficiently similar so that no change in related Work will be required, Engineer will deem it an "or equal" item. For the purposes of this paragraph, a proposed item of equipment or material will be considered functionally equal to an item so named if:
 - a. in the exercise of reasonable judgment Engineer determines that the proposed item:
 - 1) is at least equal in materials of construction, quality, durability, appearance, strength, and design characteristics;

- 2) will reliably perform at least equally well the function and achieve the results imposed by the design concept of the completed Project as a functioning whole;
 - 3) has a proven record of performance and availability of responsive service; and
 - 4) is not objectionable to Owner.
- b. Contractor certifies that, if the proposed item is approved and incorporated into the Work:
- 1) there will be no increase in cost to the Owner or increase in Contract Times; and
 - 2) the item will conform substantially to the detailed requirements of the item named in the Contract Documents.
- B. *Contractor's Expense*: Contractor shall provide all data in support of any proposed "or equal" item at Contractor's expense.
- C. *Engineer's Evaluation and Determination*: Engineer will be allowed a reasonable time to evaluate each "or-equal" request. Engineer may require Contractor to furnish additional data about the proposed "or-equal" item. Engineer will be the sole judge of acceptability. No "or-equal" item will be ordered, furnished, installed, or utilized until Engineer's review is complete and Engineer determines that the proposed item is an "or-equal," which will be evidenced by an approved Shop Drawing or other written communication. Engineer will advise Contractor in writing of any negative determination.
- D. *Effect of Engineer's Determination*: Neither approval nor denial of an "or-equal" request will result in any change in Contract Price. The Engineer's denial of an "or-equal" request will be final and binding, and may not be reversed through an appeal under any provision of the Contract.
- E. *Treatment as a Substitution Request*: If Engineer determines that an item of equipment or material proposed by Contractor does not qualify as an "or-equal" item, Contractor may request that Engineer consider the item a proposed substitute pursuant to Paragraph 7.06.

7.06 *Substitutes*

- A. *Contractor's Request; Governing Criteria*: Unless the specification or description of an item of equipment or material required to be furnished under the Contract Documents contains or is followed by words reading that no substitution is permitted, Contractor may request that Engineer authorize the use of other items of equipment or material under the circumstances described below. To the extent possible such requests must be made before commencement of related construction at the Site.
1. Contractor shall submit sufficient information as provided below to allow Engineer to determine if the item of material or equipment proposed is functionally equivalent to that named and an acceptable substitute therefor. Engineer will not accept requests for review of proposed substitute items of equipment or material from anyone other than Contractor.
 2. The requirements for review by Engineer will be as set forth in Paragraph 7.06.B, as supplemented by the Specifications, and as Engineer may decide is appropriate under the circumstances.

3. Contractor shall make written application to Engineer for review of a proposed substitute item of equipment or material that Contractor seeks to furnish or use. The application:
 - a. will certify that the proposed substitute item will:
 - 1) perform adequately the functions and achieve the results called for by the general design;
 - 2) be similar in substance to the item specified; and
 - 3) be suited to the same use as the item specified.
 - b. will state:
 - 1) the extent, if any, to which the use of the proposed substitute item will necessitate a change in Contract Times;
 - 2) whether use of the proposed substitute item in the Work will require a change in any of the Contract Documents (or in the provisions of any other direct contract with Owner for other work on the Project) to adapt the design to the proposed substitute item; and
 - 3) whether incorporation or use of the proposed substitute item in connection with the Work is subject to payment of any license fee or royalty.
 - c. will identify:
 - 1) all variations of the proposed substitute item from the item specified; and
 - 2) available engineering, sales, maintenance, repair, and replacement services.
 - d. will contain an itemized estimate of all costs or credits that will result directly or indirectly from use of such substitute item, including but not limited to changes in Contract Price, shared savings, costs of redesign, and claims of other contractors affected by any resulting change.
- B. *Engineer's Evaluation and Determination*: Engineer will be allowed a reasonable time to evaluate each substitute request, and to obtain comments and direction from Owner. Engineer may require Contractor to furnish additional data about the proposed substitute item. Engineer will be the sole judge of acceptability. No substitute will be ordered, furnished, installed, or utilized until Engineer's review is complete and Engineer determines that the proposed item is an acceptable substitute. Engineer's determination will be evidenced by a Field Order or a proposed Change Order accounting for the substitution itself and all related impacts, including changes in Contract Price or Contract Times. Engineer will advise Contractor in writing of any negative determination.
- C. *Special Guarantee*: Owner may require Contractor to furnish at Contractor's expense a special performance guarantee or other surety with respect to any substitute.
- D. *Reimbursement of Engineer's Cost*: Engineer will record Engineer's costs in evaluating a substitute proposed or submitted by Contractor. Whether or not Engineer approves a substitute so proposed or submitted by Contractor, Contractor shall reimburse Owner for the reasonable charges of Engineer for evaluating each such proposed substitute. Contractor shall also reimburse Owner for the reasonable charges of Engineer for making changes in the Contract Documents (or in the provisions of any other direct contract with Owner) resulting from the acceptance of each proposed substitute.

- E. *Contractor's Expense*: Contractor shall provide all data in support of any proposed substitute at Contractor's expense.
- F. *Effect of Engineer's Determination*: If Engineer approves the substitution request, Contractor shall execute the proposed Change Order and proceed with the substitution. The Engineer's denial of a substitution request will be final and binding, and may not be reversed through an appeal under any provision of the Contract. Contractor may challenge the scope of reimbursement costs imposed under Paragraph 7.06.D, by timely submittal of a Change Proposal.

7.07 *Concerning Subcontractors and Suppliers*

- A. Contractor may retain Subcontractors and Suppliers for the performance of parts of the Work. Such Subcontractors and Suppliers must be acceptable to Owner. The Contractor's retention of a Subcontractor or Supplier for the performance of parts of the Work will not relieve Contractor's obligation to Owner to perform and complete the Work in accordance with the Contract Documents.
- B. Contractor shall retain specific Subcontractors and Suppliers for the performance of designated parts of the Work if required by the Contract to do so.
- C. Subsequent to the submittal of Contractor's Bid or final negotiation of the terms of the Contract, Owner may not require Contractor to retain any Subcontractor or Supplier to furnish or perform any of the Work against which Contractor has reasonable objection.
- D. Prior to entry into any binding subcontract or purchase order, Contractor shall submit to Owner the identity of the proposed Subcontractor or Supplier (unless Owner has already deemed such proposed Subcontractor or Supplier acceptable during the bidding process or otherwise). Such proposed Subcontractor or Supplier shall be deemed acceptable to Owner unless Owner raises a substantive, reasonable objection within 5 days.
- E. Owner may require the replacement of any Subcontractor or Supplier. Owner also may require Contractor to retain specific replacements; provided, however, that Owner may not require a replacement to which Contractor has a reasonable objection. If Contractor has submitted the identity of certain Subcontractors or Suppliers for acceptance by Owner, and Owner has accepted it (either in writing or by failing to make written objection thereto), then Owner may subsequently revoke the acceptance of any such Subcontractor or Supplier so identified solely on the basis of substantive, reasonable objection after due investigation. Contractor shall submit an acceptable replacement for the rejected Subcontractor or Supplier.
- F. If Owner requires the replacement of any Subcontractor or Supplier retained by Contractor to perform any part of the Work, then Contractor shall be entitled to an adjustment in Contract Price or Contract Times, with respect to the replacement; and Contractor shall initiate a Change Proposal for such adjustment within 30 days of Owner's requirement of replacement.
- G. No acceptance by Owner of any such Subcontractor or Supplier, whether initially or as a replacement, will constitute a waiver of the right of Owner to the completion of the Work in accordance with the Contract Documents.

- H. On a monthly basis, Contractor shall submit to Engineer a complete list of all Subcontractors and Suppliers having a direct contract with Contractor, and of all other Subcontractors and Suppliers known to Contractor at the time of submittal.
- I. Contractor shall be solely responsible for scheduling and coordinating the work of Subcontractors and Suppliers.
- J. The divisions and sections of the Specifications and the identifications of any Drawings do not control Contractor in dividing the Work among Subcontractors or Suppliers, or in delineating the Work to be performed by any specific trade.
- K. All Work performed for Contractor by a Subcontractor or Supplier must be pursuant to an appropriate contractual agreement that specifically binds the Subcontractor or Supplier to the applicable terms and conditions of the Contract for the benefit of Owner and Engineer.
- L. Owner may furnish to any Subcontractor or Supplier, to the extent practicable, information about amounts paid to Contractor for Work performed for Contractor by the Subcontractor or Supplier.
- M. Contractor shall restrict all Subcontractors and Suppliers from communicating with Engineer or Owner, except through Contractor or in case of an emergency, or as otherwise expressly allowed in this Contract.

7.08 *Patent Fees and Royalties*

- A. Contractor shall pay all license fees and royalties and assume all costs incident to the use in the performance of the Work or the incorporation in the Work of any invention, design, process, product, or device which is the subject of patent rights or copyrights held by others. If an invention, design, process, product, or device is specified in the Contract Documents for use in the performance of the Work and if, to the actual knowledge of Owner or Engineer, its use is subject to patent rights or copyrights calling for the payment of any license fee or royalty to others, the existence of such rights will be disclosed in the Contract Documents.
- B. To the fullest extent permitted by Laws and Regulations, Owner shall indemnify and hold harmless Contractor, and its officers, directors, members, partners, employees, agents, consultants, and subcontractors, from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals, and all court or arbitration or other dispute resolution costs) arising out of or relating to any infringement of patent rights or copyrights incident to the use in the performance of the Work or resulting from the incorporation in the Work of any invention, design, process, product, or device specified in the Contract Documents, but not identified as being subject to payment of any license fee or royalty to others required by patent rights or copyrights.
- C. To the fullest extent permitted by Laws and Regulations, Contractor shall indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them, from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to any infringement of patent rights or copyrights incident to the use in the performance of the Work or resulting from the incorporation in the Work of any invention, design, process, product, or device not specified in the Contract Documents.

7.09 *Permits*

- A. Unless otherwise provided in the Contract Documents, Contractor shall obtain and pay for all construction permits, licenses, and certificates of occupancy. Owner shall assist Contractor, when necessary, in obtaining such permits and licenses. Contractor shall pay all governmental charges and inspection fees necessary for the prosecution of the Work which are applicable at the time of the submission of Contractor's Bid (or when Contractor became bound under a negotiated contract). Owner shall pay all charges of utility owners for connections for providing permanent service to the Work.

7.10 *Taxes*

- A. Contractor shall pay all sales, consumer, use, and other similar taxes required to be paid by Contractor in accordance with the Laws and Regulations of the place of the Project which are applicable during the performance of the Work.

7.11 *Laws and Regulations*

- A. Contractor shall give all notices required by and shall comply with all Laws and Regulations applicable to the performance of the Work. Neither Owner nor Engineer shall be responsible for monitoring Contractor's compliance with any Laws or Regulations.
- B. If Contractor performs any Work or takes any other action knowing or having reason to know that it is contrary to Laws or Regulations, Contractor shall bear all resulting costs and losses, and shall indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them, from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to such Work or other action. It is not Contractor's responsibility to make certain that the Work described in the Contract Documents is in accordance with Laws and Regulations, but this does not relieve Contractor of its obligations under Paragraph 3.03.
- C. Owner or Contractor may give written notice to the other party of any changes after the submission of Contractor's Bid (or after the date when Contractor became bound under a negotiated contract) in Laws or Regulations having an effect on the cost or time of performance of the Work, including but not limited to changes in Laws or Regulations having an effect on procuring permits and on sales, use, value-added, consumption, and other similar taxes. If Owner and Contractor are unable to agree on entitlement to or on the amount or extent, if any, of any adjustment in Contract Price or Contract Times resulting from such changes, then within 30 days of such written notice Contractor may submit a Change Proposal, or Owner may initiate a Claim.

7.12 *Record Documents*

- A. Contractor shall maintain in a safe place at the Site one printed record copy of all Drawings, Specifications, Addenda, Change Orders, Work Change Directives, Field Orders, written interpretations and clarifications, and approved Shop Drawings. Contractor shall keep such record documents in good order and annotate them to show changes made during construction. These record documents, together with all approved Samples, will be available to Engineer for reference. Upon completion of the Work, Contractor shall deliver these record documents to Engineer.

7.13 *Safety and Protection*

- A. Contractor shall be solely responsible for initiating, maintaining, and supervising all safety precautions and programs in connection with the Work. Such responsibility does not relieve Subcontractors of their responsibility for the safety of persons or property in the performance of their work, nor for compliance with applicable safety Laws and Regulations.
- B. Contractor shall designate a qualified and experienced safety representative whose duties and responsibilities are the prevention of Work-related accidents and the maintenance and supervision of safety precautions and programs.
- C. Contractor shall take all necessary precautions for the safety of, and shall provide the necessary protection to prevent damage, injury, or loss to:
 - 1. all persons on the Site or who may be affected by the Work;
 - 2. all the Work and materials and equipment to be incorporated therein, whether in storage on or off the Site; and
 - 3. other property at the Site or adjacent thereto, including trees, shrubs, lawns, walks, pavements, roadways, structures, other work in progress, utilities, and Underground Facilities not designated for removal, relocation, or replacement in the course of construction.
- D. All damage, injury, or loss to any property referred to in Paragraph 7.13.C.2 or 7.13.C.3 caused, directly or indirectly, in whole or in part, by Contractor, any Subcontractor, Supplier, or any other individual or entity directly or indirectly employed by any of them to perform any of the Work, or anyone for whose acts any of them may be liable, shall be remedied by Contractor at its expense (except damage or loss attributable to the fault of Drawings or Specifications or to the acts or omissions of Owner or Engineer or anyone employed by any of them, or anyone for whose acts any of them may be liable, and not attributable, directly or indirectly, in whole or in part, to the fault or negligence of Contractor or any Subcontractor, Supplier, or other individual or entity directly or indirectly employed by any of them).
- E. Contractor shall comply with all applicable Laws and Regulations relating to the safety of persons or property, or to the protection of persons or property from damage, injury, or loss; and shall erect and maintain all necessary safeguards for such safety and protection.
- F. Contractor shall notify Owner; the owners of adjacent property; the owners of Underground Facilities and other utilities (if the identity of such owners is known to Contractor); and other contractors and utility owners performing work at or adjacent to the Site, in writing, when Contractor knows that prosecution of the Work may affect them, and shall cooperate with them in the protection, removal, relocation, and replacement of their property or work in progress.
- G. Contractor shall comply with the applicable requirements of Owner's safety programs, if any. Any Owner's safety programs that are applicable to the Work are identified or included in the Supplementary Conditions or Specifications.
- H. Contractor shall inform Owner and Engineer of the specific requirements of Contractor's safety program with which Owner's and Engineer's employees and representatives must comply while at the Site.

- I. Contractor's duties and responsibilities for safety and protection will continue until all the Work is completed, Engineer has issued a written notice to Owner and Contractor in accordance with Paragraph 15.06.C that the Work is acceptable, and Contractor has left the Site (except as otherwise expressly provided in connection with Substantial Completion).
- J. Contractor's duties and responsibilities for safety and protection will resume whenever Contractor or any Subcontractor or Supplier returns to the Site to fulfill warranty or correction obligations, or to conduct other tasks arising from the Contract Documents.

7.14 *Hazard Communication Programs*

- A. Contractor shall be responsible for coordinating any exchange of safety data sheets (formerly known as material safety data sheets) or other hazard communication information required to be made available to or exchanged between or among employers at the Site in accordance with Laws or Regulations.

7.15 *Emergencies*

- A. In emergencies affecting the safety or protection of persons or the Work or property at the Site or adjacent thereto, Contractor is obligated to act to prevent damage, injury, or loss. Contractor shall give Engineer prompt written notice if Contractor believes that any significant changes in the Work or variations from the Contract Documents have been caused by an emergency, or are required as a result of Contractor's response to an emergency. If Engineer determines that a change in the Contract Documents is required because of an emergency or Contractor's response, a Work Change Directive or Change Order will be issued.

7.16 *Submittals*

A. *Shop Drawing and Sample Requirements*

- 1. Before submitting a Shop Drawing or Sample, Contractor shall:
 - a. review and coordinate the Shop Drawing or Sample with other Shop Drawings and Samples and with the requirements of the Work and the Contract Documents;
 - b. determine and verify:
 - 1) all field measurements, quantities, dimensions, specified performance and design criteria, installation requirements, materials, catalog numbers, and similar information with respect to the Submittal;
 - 2) the suitability of all materials and equipment offered with respect to the indicated application, fabrication, shipping, handling, storage, assembly, and installation pertaining to the performance of the Work; and
 - 3) all information relative to Contractor's responsibilities for means, methods, techniques, sequences, and procedures of construction, and safety precautions and programs incident thereto;
 - c. confirm that the Submittal is complete with respect to all related data included in the Submittal.
- 2. Each Shop Drawing or Sample must bear a stamp or specific written certification that Contractor has satisfied Contractor's obligations under the Contract Documents with respect to Contractor's review of that Submittal, and that Contractor approves the Submittal.

3. With each Shop Drawing or Sample, Contractor shall give Engineer specific written notice of any variations that the Submittal may have from the requirements of the Contract Documents. This notice must be set forth in a written communication separate from the Submittal; and, in addition, in the case of a Shop Drawing by a specific notation made on the Shop Drawing itself.
- B. *Submittal Procedures for Shop Drawings and Samples:* Contractor shall label and submit Shop Drawings and Samples to Engineer for review and approval in accordance with the accepted Schedule of Submittals.
1. *Shop Drawings*
 - a. Contractor shall submit the number of copies required in the Specifications.
 - b. Data shown on the Shop Drawings must be complete with respect to quantities, dimensions, specified performance and design criteria, materials, and similar data to show Engineer the services, materials, and equipment Contractor proposes to provide, and to enable Engineer to review the information for the limited purposes required by Paragraph 7.16.C.
 2. *Samples*
 - a. Contractor shall submit the number of Samples required in the Specifications.
 - b. Contractor shall clearly identify each Sample as to material, Supplier, pertinent data such as catalog numbers, the use for which intended and other data as Engineer may require to enable Engineer to review the Submittal for the limited purposes required by Paragraph 7.16.C.
 3. Where a Shop Drawing or Sample is required by the Contract Documents or the Schedule of Submittals, any related Work performed prior to Engineer's review and approval of the pertinent submittal will be at the sole expense and responsibility of Contractor.
- C. *Engineer's Review of Shop Drawings and Samples*
1. Engineer will provide timely review of Shop Drawings and Samples in accordance with the accepted Schedule of Submittals. Engineer's review and approval will be only to determine if the items covered by the Submittals will, after installation or incorporation in the Work, comply with the requirements of the Contract Documents, and be compatible with the design concept of the completed Project as a functioning whole as indicated by the Contract Documents.
 2. Engineer's review and approval will not extend to means, methods, techniques, sequences, or procedures of construction, or to safety precautions or programs incident thereto.
 3. Engineer's review and approval of a separate item as such will not indicate approval of the assembly in which the item functions.
 4. Engineer's review and approval of a Shop Drawing or Sample will not relieve Contractor from responsibility for any variation from the requirements of the Contract Documents unless Contractor has complied with the requirements of Paragraph 7.16.A.3 and Engineer has given written approval of each such variation by specific written notation thereof incorporated in or accompanying the Shop Drawing or Sample. Engineer will

document any such approved variation from the requirements of the Contract Documents in a Field Order or other appropriate Contract modification.

5. Engineer's review and approval of a Shop Drawing or Sample will not relieve Contractor from responsibility for complying with the requirements of Paragraphs 7.16.A and B.
6. Engineer's review and approval of a Shop Drawing or Sample, or of a variation from the requirements of the Contract Documents, will not, under any circumstances, change the Contract Times or Contract Price, unless such changes are included in a Change Order.
7. Neither Engineer's receipt, review, acceptance, or approval of a Shop Drawing or Sample will result in such item becoming a Contract Document.
8. Contractor shall perform the Work in compliance with the requirements and commitments set forth in approved Shop Drawings and Samples, subject to the provisions of Paragraph 7.16.C.4.

D. Resubmittal Procedures for Shop Drawings and Samples

1. Contractor shall make corrections required by Engineer and shall return the required number of corrected copies of Shop Drawings and submit, as required, new Samples for review and approval. Contractor shall direct specific attention in writing to revisions other than the corrections called for by Engineer on previous Submittals.
2. Contractor shall furnish required Shop Drawing and Sample submittals with sufficient information and accuracy to obtain required approval of an item with no more than two resubmittals. Engineer will record Engineer's time for reviewing a third or subsequent resubmittal of a Shop Drawing or Sample, and Contractor shall be responsible for Engineer's charges to Owner for such time. Owner may impose a set-off against payments due Contractor to secure reimbursement for such charges.
3. If Contractor requests a change of a previously approved Shop Drawing or Sample, Contractor shall be responsible for Engineer's charges to Owner for its review time, and Owner may impose a set-off against payments due Contractor to secure reimbursement for such charges, unless the need for such change is beyond the control of Contractor.

E. Submittals Other than Shop Drawings, Samples, and Owner-Delegated Designs

1. The following provisions apply to all Submittals other than Shop Drawings, Samples, and Owner-delegated designs:
 - a. Contractor shall submit all such Submittals to the Engineer in accordance with the Schedule of Submittals and pursuant to the applicable terms of the Contract Documents.
 - b. Engineer will provide timely review of all such Submittals in accordance with the Schedule of Submittals and return such Submittals with a notation of either Accepted or Not Accepted. Any such Submittal that is not returned within the time established in the Schedule of Submittals will be deemed accepted.
 - c. Engineer's review will be only to determine if the Submittal is acceptable under the requirements of the Contract Documents as to general form and content of the Submittal.

- d. If any such Submittal is not accepted, Contractor shall confer with Engineer regarding the reason for the non-acceptance, and resubmit an acceptable document.
 2. Procedures for the submittal and acceptance of the Progress Schedule, the Schedule of Submittals, and the Schedule of Values are set forth in Paragraphs 2.03, 2.04, and 2.05.
- F. Owner-delegated Designs: Submittals pursuant to Owner-delegated designs are governed by the provisions of Paragraph 7.19.

7.17 Contractor's General Warranty and Guarantee

- A. Contractor warrants and guarantees to Owner that all Work will be in accordance with the Contract Documents and will not be defective. Engineer is entitled to rely on Contractor's warranty and guarantee.
- B. Owner's rights under this warranty and guarantee are in addition to, and are not limited by, Owner's rights under the correction period provisions of Paragraph 15.08. The time in which Owner may enforce its warranty and guarantee rights under this Paragraph 7.17 is limited only by applicable Laws and Regulations restricting actions to enforce such rights; provided, however, that after the end of the correction period under Paragraph 15.08:
1. Owner shall give Contractor written notice of any defective Work within 60 days of the discovery that such Work is defective; and
 2. Such notice will be deemed the start of an event giving rise to a Claim under Paragraph 12.01.B, such that any related Claim must be brought within 30 days of the notice.
- C. Contractor's warranty and guarantee hereunder excludes defects or damage caused by:
1. abuse, or improper modification, maintenance, or operation, by persons other than Contractor, Subcontractors, Suppliers, or any other individual or entity for whom Contractor is responsible; or
 2. normal wear and tear under normal usage.
- D. Contractor's obligation to perform and complete the Work in accordance with the Contract Documents is absolute. None of the following will constitute an acceptance of Work that is not in accordance with the Contract Documents, a release of Contractor's obligation to perform the Work in accordance with the Contract Documents, or a release of Owner's warranty and guarantee rights under this Paragraph 7.17:
1. Observations by Engineer;
 2. Recommendation by Engineer or payment by Owner of any progress or final payment;
 3. The issuance of a certificate of Substantial Completion by Engineer or any payment related thereto by Owner;
 4. Use or occupancy of the Work or any part thereof by Owner;
 5. Any review and approval of a Shop Drawing or Sample submittal;
 6. The issuance of a notice of acceptability by Engineer;
 7. The end of the correction period established in Paragraph 15.08;
 8. Any inspection, test, or approval by others; or

9. Any correction of defective Work by Owner.
- E. If the Contract requires the Contractor to accept the assignment of a contract entered into by Owner, then the specific warranties, guarantees, and correction obligations contained in the assigned contract will govern with respect to Contractor's performance obligations to Owner for the Work described in the assigned contract.

7.18 *Indemnification*

- A. To the fullest extent permitted by Laws and Regulations, and in addition to any other obligations of Contractor under the Contract or otherwise, Contractor shall indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them, from losses, damages, costs, and judgments (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals, and all court or arbitration or other dispute resolution costs) arising from third-party claims or actions relating to or resulting from the performance or furnishing of the Work, provided that any such claim, action, loss, cost, judgment or damage is attributable to bodily injury, sickness, disease, or death, or to damage to or destruction of tangible property (other than the Work itself), including the loss of use resulting therefrom, but only to the extent caused by any negligent act or omission of Contractor, any Subcontractor, any Supplier, or any individual or entity directly or indirectly employed by any of them to perform any of the Work, or anyone for whose acts any of them may be liable.
- B. In any and all claims against Owner or Engineer, or any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors, by any employee (or the survivor or personal representative of such employee) of Contractor, any Subcontractor, any Supplier, or any individual or entity directly or indirectly employed by any of them to perform any of the Work, or anyone for whose acts any of them may be liable, the indemnification obligation under Paragraph 7.18.A will not be limited in any way by any limitation on the amount or type of damages, compensation, or benefits payable by or for Contractor or any such Subcontractor, Supplier, or other individual or entity under workers' compensation acts, disability benefit acts, or other employee benefit acts.

7.19 *Delegation of Professional Design Services*

- A. Owner may require Contractor to provide professional design services for a portion of the Work by express delegation in the Contract Documents. Such delegation will specify the performance and design criteria that such services must satisfy, and the Submittals that Contractor must furnish to Engineer with respect to the Owner-delegated design.
- B. Contractor shall cause such Owner-delegated professional design services to be provided pursuant to the professional standard of care by a properly licensed design professional, whose signature and seal must appear on all drawings, calculations, specifications, certifications, and Submittals prepared by such design professional. Such design professional must issue all certifications of design required by Laws and Regulations.
- C. If a Shop Drawing or other Submittal related to the Owner-delegated design is prepared by Contractor, a Subcontractor, or others for submittal to Engineer, then such Shop Drawing or other Submittal must bear the written approval of Contractor's design professional when submitted by Contractor to Engineer.

- D. Owner and Engineer shall be entitled to rely upon the adequacy, accuracy, and completeness of the services, certifications, and approvals performed or provided by the design professionals retained or employed by Contractor under an Owner-delegated design, subject to the professional standard of care and the performance and design criteria stated in the Contract Documents.
- E. Pursuant to this Paragraph 7.19, Engineer's review, approval, and other determinations regarding design drawings, calculations, specifications, certifications, and other Submittals furnished by Contractor pursuant to an Owner-delegated design will be only for the following limited purposes:
 - 1. Checking for conformance with the requirements of this Paragraph 7.19;
 - 2. Confirming that Contractor (through its design professionals) has used the performance and design criteria specified in the Contract Documents; and
 - 3. Establishing that the design furnished by Contractor is consistent with the design concept expressed in the Contract Documents.
- F. Contractor shall not be responsible for the adequacy of performance or design criteria specified by Owner or Engineer.
- G. Contractor is not required to provide professional services in violation of applicable Laws and Regulations.

ARTICLE 8—OTHER WORK AT THE SITE

8.01 *Other Work*

- A. In addition to and apart from the Work under the Contract Documents, the Owner may perform other work at or adjacent to the Site. Such other work may be performed by Owner's employees, or through contracts between the Owner and third parties. Owner may also arrange to have third-party utility owners perform work on their utilities and facilities at or adjacent to the Site.
- B. If Owner performs other work at or adjacent to the Site with Owner's employees, or through contracts for such other work, then Owner shall give Contractor written notice thereof prior to starting any such other work. If Owner has advance information regarding the start of any third-party utility work that Owner has arranged to take place at or adjacent to the Site, Owner shall provide such information to Contractor.
- C. Contractor shall afford proper and safe access to the Site to each contractor that performs such other work, each utility owner performing other work, and Owner, if Owner is performing other work with Owner's employees, and provide a reasonable opportunity for the introduction and storage of materials and equipment and the execution of such other work.
- D. Contractor shall do all cutting, fitting, and patching of the Work that may be required to properly connect or otherwise make its several parts come together and properly integrate with such other work. Contractor shall not endanger any work of others by cutting, excavating, or otherwise altering such work; provided, however, that Contractor may cut or alter others' work with the written consent of Engineer and the others whose work will be affected.

- E. If the proper execution or results of any part of Contractor's Work depends upon work performed by others, Contractor shall inspect such other work and promptly report to Engineer in writing any delays, defects, or deficiencies in such other work that render it unavailable or unsuitable for the proper execution and results of Contractor's Work. Contractor's failure to so report will constitute an acceptance of such other work as fit and proper for integration with Contractor's Work except for latent defects and deficiencies in such other work.
- F. The provisions of this article are not applicable to work that is performed by third-party utilities or other third-party entities without a contract with Owner, or that is performed without having been arranged by Owner. If such work occurs, then any related delay, disruption, or interference incurred by Contractor is governed by the provisions of Paragraph 4.05.C.3.

8.02 *Coordination*

- A. If Owner intends to contract with others for the performance of other work at or adjacent to the Site, to perform other work at or adjacent to the Site with Owner's employees, or to arrange to have utility owners perform work at or adjacent to the Site, the following will be set forth in the Supplementary Conditions or provided to Contractor prior to the start of any such other work:
 - 1. The identity of the individual or entity that will have authority and responsibility for coordination of the activities among the various contractors;
 - 2. An itemization of the specific matters to be covered by such authority and responsibility; and
 - 3. The extent of such authority and responsibilities.
- B. Unless otherwise provided in the Supplementary Conditions, Owner shall have sole authority and responsibility for such coordination.

8.03 *Legal Relationships*

- A. If, in the course of performing other work for Owner at or adjacent to the Site, the Owner's employees, any other contractor working for Owner, or any utility owner that Owner has arranged to perform work, causes damage to the Work or to the property of Contractor or its Subcontractors, or delays, disrupts, interferes with, or increases the scope or cost of the performance of the Work, through actions or inaction, then Contractor shall be entitled to an equitable adjustment in the Contract Price or the Contract Times. Contractor must submit any Change Proposal seeking an equitable adjustment in the Contract Price or the Contract Times under this paragraph within 30 days of the damaging, delaying, disrupting, or interfering event. The entitlement to, and extent of, any such equitable adjustment will take into account information (if any) regarding such other work that was provided to Contractor in the Contract Documents prior to the submittal of the Bid or the final negotiation of the terms of the Contract, and any remedies available to Contractor under Laws or Regulations concerning utility action or inaction. When applicable, any such equitable adjustment in Contract Price will be conditioned on Contractor assigning to Owner all Contractor's rights against such other contractor or utility owner with respect to the damage, delay, disruption, or interference that is the subject of the adjustment. Contractor's entitlement to an adjustment of the Contract Times or Contract Price is subject to the provisions of Paragraphs 4.05.D and 4.05.E.

- B. Contractor shall take reasonable and customary measures to avoid damaging, delaying, disrupting, or interfering with the work of Owner, any other contractor, or any utility owner performing other work at or adjacent to the Site.
 - 1. If Contractor fails to take such measures and as a result damages, delays, disrupts, or interferes with the work of any such other contractor or utility owner, then Owner may impose a set-off against payments due Contractor, and assign to such other contractor or utility owner the Owner's contractual rights against Contractor with respect to the breach of the obligations set forth in this Paragraph 8.03.B.
 - 2. When Owner is performing other work at or adjacent to the Site with Owner's employees, Contractor shall be liable to Owner for damage to such other work, and for the reasonable direct delay, disruption, and interference costs incurred by Owner as a result of Contractor's failure to take reasonable and customary measures with respect to Owner's other work. In response to such damage, delay, disruption, or interference, Owner may impose a set-off against payments due Contractor.
- C. If Contractor damages, delays, disrupts, or interferes with the work of any other contractor, or any utility owner performing other work at or adjacent to the Site, through Contractor's failure to take reasonable and customary measures to avoid such impacts, or if any claim arising out of Contractor's actions, inactions, or negligence in performance of the Work at or adjacent to the Site is made by any such other contractor or utility owner against Contractor, Owner, or Engineer, then Contractor shall (1) promptly attempt to settle the claim as to all parties through negotiations with such other contractor or utility owner, or otherwise resolve the claim by arbitration or other dispute resolution proceeding or at law, and (2) indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them from and against any such claims, and against all costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to such damage, delay, disruption, or interference.

ARTICLE 9—OWNER'S RESPONSIBILITIES

9.01 *Communications to Contractor*

- A. Except as otherwise provided in these General Conditions, Owner shall issue all communications to Contractor through Engineer.

9.02 *Replacement of Engineer*

- A. Owner may at its discretion appoint an engineer to replace Engineer, provided Contractor makes no reasonable objection to the replacement engineer. The replacement engineer's status under the Contract Documents will be that of the former Engineer.

9.03 *Furnish Data*

- A. Owner shall promptly furnish the data required of Owner under the Contract Documents.

9.04 *Pay When Due*

- A. Owner shall make payments to Contractor when they are due as provided in the Agreement.

- 9.05 *Lands and Easements; Reports, Tests, and Drawings*
- A. Owner's duties with respect to providing lands and easements are set forth in Paragraph 5.01.
 - B. Owner's duties with respect to providing engineering surveys to establish reference points are set forth in Paragraph 4.03.
 - C. Article 5 refers to Owner's identifying and making available to Contractor copies of reports of explorations and tests of conditions at the Site, and drawings of physical conditions relating to existing surface or subsurface structures at the Site.
- 9.06 *Insurance*
- A. Owner's responsibilities, if any, with respect to purchasing and maintaining liability and property insurance are set forth in Article 6.
- 9.07 *Change Orders*
- A. Owner's responsibilities with respect to Change Orders are set forth in Article 11.
- 9.08 *Inspections, Tests, and Approvals*
- A. Owner's responsibility with respect to certain inspections, tests, and approvals is set forth in Paragraph 14.02.B.
- 9.09 *Limitations on Owner's Responsibilities*
- A. The Owner shall not supervise, direct, or have control or authority over, nor be responsible for, Contractor's means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of Contractor to comply with Laws and Regulations applicable to the performance of the Work. Owner will not be responsible for Contractor's failure to perform the Work in accordance with the Contract Documents.
- 9.10 *Undisclosed Hazardous Environmental Condition*
- A. Owner's responsibility in respect to an undisclosed Hazardous Environmental Condition is set forth in Paragraph 5.06.
- 9.11 *Evidence of Financial Arrangements*
- A. Upon request of Contractor, Owner shall furnish Contractor reasonable evidence that financial arrangements have been made to satisfy Owner's obligations under the Contract (including obligations under proposed changes in the Work).
- 9.12 *Safety Programs*
- A. While at the Site, Owner's employees and representatives shall comply with the specific applicable requirements of Contractor's safety programs of which Owner has been informed.
 - B. Owner shall furnish copies of any applicable Owner safety programs to Contractor.

ARTICLE 10—ENGINEER'S STATUS DURING CONSTRUCTION

10.01 *Owner's Representative*

- A. Engineer will be Owner's representative during the construction period. The duties and responsibilities and the limitations of authority of Engineer as Owner's representative during construction are set forth in the Contract.

10.02 *Visits to Site*

- A. Engineer will make visits to the Site at intervals appropriate to the various stages of construction as Engineer deems necessary in order to observe, as an experienced and qualified design professional, the progress that has been made and the quality of the various aspects of Contractor's executed Work. Based on information obtained during such visits and observations, Engineer, for the benefit of Owner, will determine, in general, if the Work is proceeding in accordance with the Contract Documents. Engineer will not be required to make exhaustive or continuous inspections on the Site to check the quality or quantity of the Work. Engineer's efforts will be directed toward providing for Owner a greater degree of confidence that the completed Work will conform generally to the Contract Documents. On the basis of such visits and observations, Engineer will keep Owner informed of the progress of the Work and will endeavor to guard Owner against defective Work.
- B. Engineer's visits and observations are subject to all the limitations on Engineer's authority and responsibility set forth in Paragraph 10.07. Particularly, but without limitation, during or as a result of Engineer's visits or observations of Contractor's Work, Engineer will not supervise, direct, control, or have authority over or be responsible for Contractor's means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of Contractor to comply with Laws and Regulations applicable to the performance of the Work.

10.03 *Resident Project Representative*

- A. If Owner and Engineer have agreed that Engineer will furnish a Resident Project Representative to represent Engineer at the Site and assist Engineer in observing the progress and quality of the Work, then the authority and responsibilities of any such Resident Project Representative will be as provided in the Supplementary Conditions, and limitations on the responsibilities thereof will be as provided in the Supplementary Conditions and in Paragraph 10.07.
- B. If Owner designates an individual or entity who is not Engineer's consultant, agent, or employee to represent Owner at the Site, then the responsibilities and authority of such individual or entity will be as provided in the Supplementary Conditions.

10.04 *Engineer's Authority*

- A. Engineer has the authority to reject Work in accordance with Article 14.
- B. Engineer's authority as to Submittals is set forth in Paragraph 7.16.
- C. Engineer's authority as to design drawings, calculations, specifications, certifications and other Submittals from Contractor in response to Owner's delegation (if any) to Contractor of professional design services, is set forth in Paragraph 7.19.
- D. Engineer's authority as to changes in the Work is set forth in Article 11.

E. Engineer's authority as to Applications for Payment is set forth in Article 15.

10.05 *Determinations for Unit Price Work*

A. Engineer will determine the actual quantities and classifications of Unit Price Work performed by Contractor as set forth in Paragraph 13.03.

10.06 *Decisions on Requirements of Contract Documents and Acceptability of Work*

A. Engineer will render decisions regarding the requirements of the Contract Documents, and judge the acceptability of the Work, pursuant to the specific procedures set forth herein for initial interpretations, Change Proposals, and acceptance of the Work. In rendering such decisions and judgments, Engineer will not show partiality to Owner or Contractor, and will not be liable to Owner, Contractor, or others in connection with any proceedings, interpretations, decisions, or judgments conducted or rendered in good faith.

10.07 *Limitations on Engineer's Authority and Responsibilities*

A. Neither Engineer's authority or responsibility under this Article 10 or under any other provision of the Contract, nor any decision made by Engineer in good faith either to exercise or not exercise such authority or responsibility or the undertaking, exercise, or performance of any authority or responsibility by Engineer, will create, impose, or give rise to any duty in contract, tort, or otherwise owed by Engineer to Contractor, any Subcontractor, any Supplier, any other individual or entity, or to any surety for or employee or agent of any of them.

B. Engineer will not supervise, direct, control, or have authority over or be responsible for Contractor's means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of Contractor to comply with Laws and Regulations applicable to the performance of the Work. Engineer will not be responsible for Contractor's failure to perform the Work in accordance with the Contract Documents.

C. Engineer will not be responsible for the acts or omissions of Contractor or of any Subcontractor, any Supplier, or of any other individual or entity performing any of the Work.

D. Engineer's review of the final Application for Payment and accompanying documentation, and all maintenance and operating instructions, schedules, guarantees, bonds, certificates of inspection, tests and approvals, and other documentation required to be delivered by Contractor under Paragraph 15.06.A, will only be to determine generally that their content complies with the requirements of, and in the case of certificates of inspections, tests, and approvals, that the results certified indicate compliance with the Contract Documents.

E. The limitations upon authority and responsibility set forth in this Paragraph 10.07 also apply to the Resident Project Representative, if any.

10.08 *Compliance with Safety Program*

A. While at the Site, Engineer's employees and representatives will comply with the specific applicable requirements of Owner's and Contractor's safety programs of which Engineer has been informed.

ARTICLE 11—CHANGES TO THE CONTRACT

11.01 *Amending and Supplementing the Contract*

- A. The Contract may be amended or supplemented by a Change Order, a Work Change Directive, or a Field Order.
- B. If an amendment or supplement to the Contract includes a change in the Contract Price or the Contract Times, such amendment or supplement must be set forth in a Change Order.
- C. All changes to the Contract that involve (1) the performance or acceptability of the Work, (2) the design (as set forth in the Drawings, Specifications, or otherwise), or (3) other engineering or technical matters, must be supported by Engineer's recommendation. Owner and Contractor may amend other terms and conditions of the Contract without the recommendation of the Engineer.

11.02 *Change Orders*

- A. Owner and Contractor shall execute appropriate Change Orders covering:
 - 1. Changes in Contract Price or Contract Times which are agreed to by the parties, including any undisputed sum or amount of time for Work actually performed in accordance with a Work Change Directive;
 - 2. Changes in Contract Price resulting from an Owner set-off, unless Contractor has duly contested such set-off;
 - 3. Changes in the Work which are: (a) ordered by Owner pursuant to Paragraph 11.05, (b) required because of Owner's acceptance of defective Work under Paragraph 14.04 or Owner's correction of defective Work under Paragraph 14.07, or (c) agreed to by the parties, subject to the need for Engineer's recommendation if the change in the Work involves the design (as set forth in the Drawings, Specifications, or otherwise) or other engineering or technical matters; and
 - 4. Changes that embody the substance of any final and binding results under: Paragraph 11.03.B, resolving the impact of a Work Change Directive; Paragraph 11.09, concerning Change Proposals; Article 12, Claims; Paragraph 13.02.D, final adjustments resulting from allowances; Paragraph 13.03.D, final adjustments relating to determination of quantities for Unit Price Work; and similar provisions.
- B. If Owner or Contractor refuses to execute a Change Order that is required to be executed under the terms of Paragraph 11.02.A, it will be deemed to be of full force and effect, as if fully executed.

11.03 *Work Change Directives*

- A. A Work Change Directive will not change the Contract Price or the Contract Times but is evidence that the parties expect that the modification ordered or documented by a Work Change Directive will be incorporated in a subsequently issued Change Order, following negotiations by the parties as to the Work Change Directive's effect, if any, on the Contract Price and Contract Times; or, if negotiations are unsuccessful, by a determination under the terms of the Contract Documents governing adjustments, expressly including Paragraph 11.07 regarding change of Contract Price.

- B. If Owner has issued a Work Change Directive and:
 - 1. Contractor believes that an adjustment in Contract Times or Contract Price is necessary, then Contractor shall submit any Change Proposal seeking such an adjustment no later than 30 days after the completion of the Work set out in the Work Change Directive.
 - 2. Owner believes that an adjustment in Contract Times or Contract Price is necessary, then Owner shall submit any Claim seeking such an adjustment no later than 60 days after issuance of the Work Change Directive.

11.04 *Field Orders*

- A. Engineer may authorize minor changes in the Work if the changes do not involve an adjustment in the Contract Price or the Contract Times and are compatible with the design concept of the completed Project as a functioning whole as indicated by the Contract Documents. Such changes will be accomplished by a Field Order and will be binding on Owner and also on Contractor, which shall perform the Work involved promptly.
- B. If Contractor believes that a Field Order justifies an adjustment in the Contract Price or Contract Times, then before proceeding with the Work at issue, Contractor shall submit a Change Proposal as provided herein.

11.05 *Owner-Authorized Changes in the Work*

- A. Without invalidating the Contract and without notice to any surety, Owner may, at any time or from time to time, order additions, deletions, or revisions in the Work. Changes involving the design (as set forth in the Drawings, Specifications, or otherwise) or other engineering or technical matters will be supported by Engineer's recommendation.
- B. Such changes in the Work may be accomplished by a Change Order, if Owner and Contractor have agreed as to the effect, if any, of the changes on Contract Times or Contract Price; or by a Work Change Directive. Upon receipt of any such document, Contractor shall promptly proceed with the Work involved; or, in the case of a deletion in the Work, promptly cease construction activities with respect to such deleted Work. Added or revised Work must be performed under the applicable conditions of the Contract Documents.
- C. Nothing in this Paragraph 11.05 obligates Contractor to undertake work that Contractor reasonably concludes cannot be performed in a manner consistent with Contractor's safety obligations under the Contract Documents or Laws and Regulations.

11.06 *Unauthorized Changes in the Work*

- A. Contractor shall not be entitled to an increase in the Contract Price or an extension of the Contract Times with respect to any work performed that is not required by the Contract Documents, as amended, modified, or supplemented, except in the case of an emergency as provided in Paragraph 7.15 or in the case of uncovering Work as provided in Paragraph 14.05.C.2.

11.07 *Change of Contract Price*

- A. The Contract Price may only be changed by a Change Order. Any Change Proposal for an adjustment in the Contract Price must comply with the provisions of Paragraph 11.09. Any Claim for an adjustment of Contract Price must comply with the provisions of Article 12.
- B. An adjustment in the Contract Price will be determined as follows:

1. Where the Work involved is covered by unit prices contained in the Contract Documents, then by application of such unit prices to the quantities of the items involved (subject to the provisions of Paragraph 13.03);
 2. Where the Work involved is not covered by unit prices contained in the Contract Documents, then by a mutually agreed lump sum (which may include an allowance for overhead and profit not necessarily in accordance with Paragraph 11.07.C.2); or
 3. Where the Work involved is not covered by unit prices contained in the Contract Documents and the parties do not reach mutual agreement to a lump sum, then on the basis of the Cost of the Work (determined as provided in Paragraph 13.01) plus a Contractor's fee for overhead and profit (determined as provided in Paragraph 11.07.C).
- C. *Contractor's Fee*: When applicable, the Contractor's fee for overhead and profit will be determined as follows:
1. A mutually acceptable fixed fee; or
 2. If a fixed fee is not agreed upon, then a fee based on the following percentages of the various portions of the Cost of the Work:
 - a. For costs incurred under Paragraphs 13.01.B.1 and 13.01.B.2, the Contractor's fee will be 15 percent;
 - b. For costs incurred under Paragraph 13.01.B.3, the Contractor's fee will be 5 percent;
 - c. Where one or more tiers of subcontracts are on the basis of Cost of the Work plus a fee and no fixed fee is agreed upon, the intent of Paragraphs 11.07.C.2.a and 11.07.C.2.b is that the Contractor's fee will be based on: (1) a fee of 15 percent of the costs incurred under Paragraphs 13.01.B.1 and 13.01.B.2 by the Subcontractor that actually performs the Work, at whatever tier, and (2) with respect to Contractor itself and to any Subcontractors of a tier higher than that of the Subcontractor that actually performs the Work, a fee of 5 percent of the amount (fee plus underlying costs incurred) attributable to the next lower tier Subcontractor; provided, however, that for any such subcontracted Work the maximum total fee to be paid by Owner will be no greater than 27 percent of the costs incurred by the Subcontractor that actually performs the Work;
 - d. No fee will be payable on the basis of costs itemized under Paragraphs 13.01.B.4, 13.01.B.5, and 13.01.C;
 - e. The amount of credit to be allowed by Contractor to Owner for any change which results in a net decrease in Cost of the Work will be the amount of the actual net decrease in Cost of the Work and a deduction of an additional amount equal to 5 percent of such actual net decrease in Cost of the Work; and
 - f. When both additions and credits are involved in any one change or Change Proposal, the adjustment in Contractor's fee will be computed by determining the sum of the costs in each of the cost categories in Paragraph 13.01.B (specifically, payroll costs, Paragraph 13.01.B.1; incorporated materials and equipment costs, Paragraph 13.01.B.2; Subcontract costs, Paragraph 13.01.B.3; special consultants costs, Paragraph 13.01.B.4; and other costs, Paragraph 13.01.B.5) and applying to each such cost category sum the appropriate fee from Paragraphs 11.07.C.2.a through 11.07.C.2.e, inclusive.

11.08 *Change of Contract Times*

- A. The Contract Times may only be changed by a Change Order. Any Change Proposal for an adjustment in the Contract Times must comply with the provisions of Paragraph 11.09. Any Claim for an adjustment in the Contract Times must comply with the provisions of Article 12.
- B. Delay, disruption, and interference in the Work, and any related changes in Contract Times, are addressed in and governed by Paragraph 4.05.

11.09 *Change Proposals*

- A. *Purpose and Content:* Contractor shall submit a Change Proposal to Engineer to request an adjustment in the Contract Times or Contract Price; contest an initial decision by Engineer concerning the requirements of the Contract Documents or relating to the acceptability of the Work under the Contract Documents; challenge a set-off against payment due; or seek other relief under the Contract. The Change Proposal will specify any proposed change in Contract Times or Contract Price, or other proposed relief, and explain the reason for the proposed change, with citations to any governing or applicable provisions of the Contract Documents. Each Change Proposal will address only one issue, or a set of closely related issues.

B. *Change Proposal Procedures*

1. *Submittal:* Contractor shall submit each Change Proposal to Engineer within 30 days after the start of the event giving rise thereto, or after such initial decision.
2. *Supporting Data:* The Contractor shall submit supporting data, including the proposed change in Contract Price or Contract Time (if any), to the Engineer and Owner within 15 days after the submittal of the Change Proposal.
 - a. Change Proposals based on or related to delay, interruption, or interference must comply with the provisions of Paragraphs 4.05.D and 4.05.E.
 - b. Change proposals related to a change of Contract Price must include full and detailed accounts of materials incorporated into the Work and labor and equipment used for the subject Work.

The supporting data must be accompanied by a written statement that the supporting data are accurate and complete, and that any requested time or price adjustment is the entire adjustment to which Contractor believes it is entitled as a result of said event.

3. *Engineer's Initial Review:* Engineer will advise Owner regarding the Change Proposal, and consider any comments or response from Owner regarding the Change Proposal. If in its discretion Engineer concludes that additional supporting data is needed before conducting a full review and making a decision regarding the Change Proposal, then Engineer may request that Contractor submit such additional supporting data by a date specified by Engineer, prior to Engineer beginning its full review of the Change Proposal.
4. *Engineer's Full Review and Action on the Change Proposal:* Upon receipt of Contractor's supporting data (including any additional data requested by Engineer), Engineer will conduct a full review of each Change Proposal and, within 30 days after such receipt of the Contractor's supporting data, either approve the Change Proposal in whole, deny it in whole, or approve it in part and deny it in part. Such actions must be in writing, with a copy provided to Owner and Contractor. If Engineer does not take action on the Change

Proposal within 30 days, then either Owner or Contractor may at any time thereafter submit a letter to the other party indicating that as a result of Engineer's inaction the Change Proposal is deemed denied, thereby commencing the time for appeal of the denial under Article 12.

5. *Binding Decision*: Engineer's decision is final and binding upon Owner and Contractor, unless Owner or Contractor appeals the decision by filing a Claim under Article 12.
- C. *Resolution of Certain Change Proposals*: If the Change Proposal does not involve the design (as set forth in the Drawings, Specifications, or otherwise), the acceptability of the Work, or other engineering or technical matters, then Engineer will notify the parties in writing that the Engineer is unable to resolve the Change Proposal. For purposes of further resolution of such a Change Proposal, such notice will be deemed a denial, and Contractor may choose to seek resolution under the terms of Article 12.
- D. *Post-Completion*: Contractor shall not submit any Change Proposals after Engineer issues a written recommendation of final payment pursuant to Paragraph 15.06.B.

11.10 *Notification to Surety*

- A. If the provisions of any bond require notice to be given to a surety of any change affecting the general scope of the Work or the provisions of the Contract Documents (including, but not limited to, Contract Price or Contract Times), the giving of any such notice will be Contractor's responsibility. The amount of each applicable bond will be adjusted to reflect the effect of any such change.

ARTICLE 12—CLAIMS

12.01 *Claims*

- A. *Claims Process*: The following disputes between Owner and Contractor are subject to the Claims process set forth in this article:
 1. Appeals by Owner or Contractor of Engineer's decisions regarding Change Proposals;
 2. Owner demands for adjustments in the Contract Price or Contract Times, or other relief under the Contract Documents;
 3. Disputes that Engineer has been unable to address because they do not involve the design (as set forth in the Drawings, Specifications, or otherwise), the acceptability of the Work, or other engineering or technical matters; and
 4. Subject to the waiver provisions of Paragraph 15.07, any dispute arising after Engineer has issued a written recommendation of final payment pursuant to Paragraph 15.06.B.
- B. *Submittal of Claim*: The party submitting a Claim shall deliver it directly to the other party to the Contract promptly (but in no event later than 30 days) after the start of the event giving rise thereto; in the case of appeals regarding Change Proposals within 30 days of the decision under appeal. The party submitting the Claim shall also furnish a copy to the Engineer, for its information only. The responsibility to substantiate a Claim rests with the party making the Claim. In the case of a Claim by Contractor seeking an increase in the Contract Times or Contract Price, Contractor shall certify that the Claim is made in good faith, that the supporting data are accurate and complete, and that to the best of Contractor's knowledge

and belief the amount of time or money requested accurately reflects the full amount to which Contractor is entitled.

- C. *Review and Resolution*: The party receiving a Claim shall review it thoroughly, giving full consideration to its merits. The two parties shall seek to resolve the Claim through the exchange of information and direct negotiations. The parties may extend the time for resolving the Claim by mutual agreement. All actions taken on a Claim will be stated in writing and submitted to the other party, with a copy to Engineer.
- D. *Mediation*
 - 1. At any time after initiation of a Claim, Owner and Contractor may mutually agree to mediation of the underlying dispute. The agreement to mediate will stay the Claim submittal and response process.
 - 2. If Owner and Contractor agree to mediation, then after 60 days from such agreement, either Owner or Contractor may unilaterally terminate the mediation process, and the Claim submittal and decision process will resume as of the date of the termination. If the mediation proceeds but is unsuccessful in resolving the dispute, the Claim submittal and decision process will resume as of the date of the conclusion of the mediation, as determined by the mediator.
 - 3. Owner and Contractor shall each pay one-half of the mediator's fees and costs.
- E. *Partial Approval*: If the party receiving a Claim approves the Claim in part and denies it in part, such action will be final and binding unless within 30 days of such action the other party invokes the procedure set forth in Article 17 for final resolution of disputes.
- F. *Denial of Claim*: If efforts to resolve a Claim are not successful, the party receiving the Claim may deny it by giving written notice of denial to the other party. If the receiving party does not take action on the Claim within 90 days, then either Owner or Contractor may at any time thereafter submit a letter to the other party indicating that as a result of the inaction, the Claim is deemed denied, thereby commencing the time for appeal of the denial. A denial of the Claim will be final and binding unless within 30 days of the denial the other party invokes the procedure set forth in Article 17 for the final resolution of disputes.
- G. *Final and Binding Results*: If the parties reach a mutual agreement regarding a Claim, whether through approval of the Claim, direct negotiations, mediation, or otherwise; or if a Claim is approved in part and denied in part, or denied in full, and such actions become final and binding; then the results of the agreement or action on the Claim will be incorporated in a Change Order or other written document to the extent they affect the Contract, including the Work, the Contract Times, or the Contract Price.

ARTICLE 13—COST OF THE WORK; ALLOWANCES; UNIT PRICE WORK

13.01 *Cost of the Work*

- A. *Purposes for Determination of Cost of the Work*: The term Cost of the Work means the sum of all costs necessary for the proper performance of the Work at issue, as further defined below. The provisions of this Paragraph 13.01 are used for two distinct purposes:
 - 1. To determine Cost of the Work when Cost of the Work is a component of the Contract Price, under cost-plus-fee, time-and-materials, or other cost-based terms; or

2. When needed to determine the value of a Change Order, Change Proposal, Claim, set-off, or other adjustment in Contract Price. When the value of any such adjustment is determined on the basis of Cost of the Work, Contractor is entitled only to those additional or incremental costs required because of the change in the Work or because of the event giving rise to the adjustment.
- B. *Costs Included:* Except as otherwise may be agreed to in writing by Owner, costs included in the Cost of the Work will be in amounts no higher than those commonly incurred in the locality of the Project, will not include any of the costs itemized in Paragraph 13.01.C, and will include only the following items:
1. Payroll costs for employees in the direct employ of Contractor in the performance of the Work under schedules of job classifications agreed upon by Owner and Contractor in advance of the subject Work. Such employees include, without limitation, superintendents, foremen, safety managers, safety representatives, and other personnel employed full time on the Work. Payroll costs for employees not employed full time on the Work will be apportioned on the basis of their time spent on the Work. Payroll costs include, but are not limited to, salaries and wages plus the cost of fringe benefits, which include social security contributions, unemployment, excise, and payroll taxes, workers' compensation, health and retirement benefits, sick leave, and vacation and holiday pay applicable thereto. The expenses of performing Work outside of regular working hours, on Saturday, Sunday, or legal holidays, will be included in the above to the extent authorized by Owner.
 2. Cost of all materials and equipment furnished and incorporated in the Work, including costs of transportation and storage thereof, and Suppliers' field services required in connection therewith. All cash discounts accrue to Contractor unless Owner deposits funds with Contractor with which to make payments, in which case the cash discounts will accrue to Owner. All trade discounts, rebates, and refunds and returns from sale of surplus materials and equipment will accrue to Owner, and Contractor shall make provisions so that they may be obtained.
 3. Payments made by Contractor to Subcontractors for Work performed by Subcontractors. If required by Owner, Contractor shall obtain competitive bids from subcontractors acceptable to Owner and Contractor and shall deliver such bids to Owner, which will then determine, with the advice of Engineer, which bids, if any, will be acceptable. If any subcontract provides that the Subcontractor is to be paid on the basis of Cost of the Work plus a fee, the Subcontractor's Cost of the Work and fee will be determined in the same manner as Contractor's Cost of the Work and fee as provided in this Paragraph 13.01.
 4. Costs of special consultants (including but not limited to engineers, architects, testing laboratories, surveyors, attorneys, and accountants) employed or retained for services specifically related to the Work.
 5. Other costs consisting of the following:
 - a. The proportion of necessary transportation, travel, and subsistence expenses of Contractor's employees incurred in discharge of duties connected with the Work.
 - b. Cost, including transportation and maintenance, of all materials, supplies, equipment, machinery, appliances, office, and temporary facilities at the Site, which are

consumed in the performance of the Work, and cost, less market value, of such items used but not consumed which remain the property of Contractor.

- 1) In establishing included costs for materials such as scaffolding, plating, or sheeting, consideration will be given to the actual or the estimated life of the material for use on other projects; or rental rates may be established on the basis of purchase or salvage value of such items, whichever is less. Contractor will not be eligible for compensation for such items in an amount that exceeds the purchase cost of such item.

c. *Construction Equipment Rental*

- 1) Rentals of all construction equipment and machinery, and the parts thereof, in accordance with rental agreements approved by Owner as to price (including any surcharge or special rates applicable to overtime use of the construction equipment or machinery), and the costs of transportation, loading, unloading, assembly, dismantling, and removal thereof. All such costs will be in accordance with the terms of said rental agreements. The rental of any such equipment, machinery, or parts must cease when the use thereof is no longer necessary for the Work.
- 2) Costs for equipment and machinery owned by Contractor or a Contractor-related entity will be paid at a rate shown for such equipment in the equipment rental rate book specified in the Supplementary Conditions. An hourly rate will be computed by dividing the monthly rates by 176. These computed rates will include all operating costs.
- 3) With respect to Work that is the result of a Change Order, Change Proposal, Claim, set-off, or other adjustment in Contract Price ("changed Work"), included costs will be based on the time the equipment or machinery is in use on the changed Work and the costs of transportation, loading, unloading, assembly, dismantling, and removal when directly attributable to the changed Work. The cost of any such equipment or machinery, or parts thereof, must cease to accrue when the use thereof is no longer necessary for the changed Work.

- d. Sales, consumer, use, and other similar taxes related to the Work, and for which Contractor is liable, as imposed by Laws and Regulations.
- e. Deposits lost for causes other than negligence of Contractor, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable, and royalty payments and fees for permits and licenses.
- f. Losses and damages (and related expenses) caused by damage to the Work, not compensated by insurance or otherwise, sustained by Contractor in connection with the performance of the Work (except losses and damages within the deductible amounts of builder's risk or other property insurance established in accordance with Paragraph 6.04), provided such losses and damages have resulted from causes other than the negligence of Contractor, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable. Such losses include settlements made with the written consent and approval of Owner. No such losses, damages, and expenses will be included in the Cost of the Work for the purpose of determining Contractor's fee.

- g. The cost of utilities, fuel, and sanitary facilities at the Site.
- h. Minor expenses such as communication service at the Site, express and courier services, and similar petty cash items in connection with the Work.
- i. The costs of premiums for all bonds and insurance that Contractor is required by the Contract Documents to purchase and maintain.

C. *Costs Excluded*: The term Cost of the Work does not include any of the following items:

- 1. Payroll costs and other compensation of Contractor's officers, executives, principals, general managers, engineers, architects, estimators, attorneys, auditors, accountants, purchasing and contracting agents, expeditors, timekeepers, clerks, and other personnel employed by Contractor, whether at the Site or in Contractor's principal or branch office for general administration of the Work and not specifically included in the agreed upon schedule of job classifications referred to in Paragraph 13.01.B.1 or specifically covered by Paragraph 13.01.B.4. The payroll costs and other compensation excluded here are to be considered administrative costs covered by the Contractor's fee.
- 2. The cost of purchasing, renting, or furnishing small tools and hand tools.
- 3. Expenses of Contractor's principal and branch offices other than Contractor's office at the Site.
- 4. Any part of Contractor's capital expenses, including interest on Contractor's capital employed for the Work and charges against Contractor for delinquent payments.
- 5. Costs due to the negligence of Contractor, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable, including but not limited to, the correction of defective Work, disposal of materials or equipment wrongly supplied, and making good any damage to property.
- 6. Expenses incurred in preparing and advancing Claims.
- 7. Other overhead or general expense costs of any kind and the costs of any item not specifically and expressly included in Paragraph 13.01.B.

D. *Contractor's Fee*

- 1. When the Work as a whole is performed on the basis of cost-plus-a-fee, then:
 - a. Contractor's fee for the Work set forth in the Contract Documents as of the Effective Date of the Contract will be determined as set forth in the Agreement.
 - b. for any Work covered by a Change Order, Change Proposal, Claim, set-off, or other adjustment in Contract Price on the basis of Cost of the Work, Contractor's fee will be determined as follows:
 - 1) When the fee for the Work as a whole is a percentage of the Cost of the Work, the fee will automatically adjust as the Cost of the Work changes.
 - 2) When the fee for the Work as a whole is a fixed fee, the fee for any additions or deletions will be determined in accordance with Paragraph 11.07.C.2.
- 2. When the Work as a whole is performed on the basis of a stipulated sum, or any other basis other than cost-plus-a-fee, then Contractor's fee for any Work covered by a Change

Order, Change Proposal, Claim, set-off, or other adjustment in Contract Price on the basis of Cost of the Work will be determined in accordance with Paragraph 11.07.C.2.

- E. *Documentation and Audit*: Whenever the Cost of the Work for any purpose is to be determined pursuant to this Article 13, Contractor and pertinent Subcontractors will establish and maintain records of the costs in accordance with generally accepted accounting practices. Subject to prior written notice, Owner will be afforded reasonable access, during normal business hours, to all Contractor's accounts, records, books, correspondence, instructions, drawings, receipts, vouchers, memoranda, and similar data relating to the Cost of the Work and Contractor's fee. Contractor shall preserve all such documents for a period of three years after the final payment by Owner. Pertinent Subcontractors will afford such access to Owner, and preserve such documents, to the same extent required of Contractor.

13.02 Allowances

- A. It is understood that Contractor has included in the Contract Price all allowances so named in the Contract Documents and shall cause the Work so covered to be performed for such sums and by such persons or entities as may be acceptable to Owner and Engineer.
- B. *Cash Allowances*: Contractor agrees that:
1. the cash allowances include the cost to Contractor (less any applicable trade discounts) of materials and equipment required by the allowances to be delivered at the Site, and all applicable taxes; and
 2. Contractor's costs for unloading and handling on the Site, labor, installation, overhead, profit, and other expenses contemplated for the cash allowances have been included in the Contract Price and not in the allowances, and no demand for additional payment for any of the foregoing will be valid.
- C. *Owner's Contingency Allowance*: Contractor agrees that an Owner's contingency allowance, if any, is for the sole use of Owner to cover unanticipated costs.
- D. Prior to final payment, an appropriate Change Order will be issued as recommended by Engineer to reflect actual amounts due Contractor for Work covered by allowances, and the Contract Price will be correspondingly adjusted.

13.03 Unit Price Work

- A. Where the Contract Documents provide that all or part of the Work is to be Unit Price Work, initially the Contract Price will be deemed to include for all Unit Price Work an amount equal to the sum of the unit price for each separately identified item of Unit Price Work times the estimated quantity of each item as indicated in the Agreement.
- B. The estimated quantities of items of Unit Price Work are not guaranteed and are solely for the purpose of comparison of Bids and determining an initial Contract Price. Payments to Contractor for Unit Price Work will be based on actual quantities.
- C. Each unit price will be deemed to include an amount considered by Contractor to be adequate to cover Contractor's overhead and profit for each separately identified item.
- D. Engineer will determine the actual quantities and classifications of Unit Price Work performed by Contractor. Engineer will review with Contractor the Engineer's preliminary determinations on such matters before rendering a written decision thereon (by recommendation of an Application for Payment or otherwise). Engineer's written decision

thereon will be final and binding (except as modified by Engineer to reflect changed factual conditions or more accurate data) upon Owner and Contractor, and the final adjustment of Contract Price will be set forth in a Change Order, subject to the provisions of the following paragraph.

E. *Adjustments in Unit Price*

1. Contractor or Owner shall be entitled to an adjustment in the unit price with respect to an item of Unit Price Work if:
 - a. the quantity of the item of Unit Price Work performed by Contractor differs materially and significantly from the estimated quantity of such item indicated in the Agreement; and
 - b. Contractor's unit costs to perform the item of Unit Price Work have changed materially and significantly as a result of the quantity change.
2. The adjustment in unit price will account for and be coordinated with any related changes in quantities of other items of Work, and in Contractor's costs to perform such other Work, such that the resulting overall change in Contract Price is equitable to Owner and Contractor.
3. Adjusted unit prices will apply to all units of that item.

ARTICLE 14—TESTS AND INSPECTIONS; CORRECTION, REMOVAL, OR ACCEPTANCE OF DEFECTIVE WORK

14.01 *Access to Work*

- A. Owner, Engineer, their consultants and other representatives and personnel of Owner, independent testing laboratories, and authorities having jurisdiction have access to the Site and the Work at reasonable times for their observation, inspection, and testing. Contractor shall provide them proper and safe conditions for such access and advise them of Contractor's safety procedures and programs so that they may comply with such procedures and programs as applicable.

14.02 *Tests, Inspections, and Approvals*

- A. Contractor shall give Engineer timely notice of readiness of the Work (or specific parts thereof) for all required inspections and tests, and shall cooperate with inspection and testing personnel to facilitate required inspections and tests.
- B. Owner shall retain and pay for the services of an independent inspector, testing laboratory, or other qualified individual or entity to perform all inspections and tests expressly required by the Contract Documents to be furnished and paid for by Owner, except that costs incurred in connection with tests or inspections of covered Work will be governed by the provisions of Paragraph 14.05.
- C. If Laws or Regulations of any public body having jurisdiction require any Work (or part thereof) specifically to be inspected, tested, or approved by an employee or other representative of such public body, Contractor shall assume full responsibility for arranging and obtaining such inspections, tests, or approvals, pay all costs in connection therewith, and furnish Engineer the required certificates of inspection or approval.

- D. Contractor shall be responsible for arranging, obtaining, and paying for all inspections and tests required:
1. by the Contract Documents, unless the Contract Documents expressly allocate responsibility for a specific inspection or test to Owner;
 2. to attain Owner's and Engineer's acceptance of materials or equipment to be incorporated in the Work;
 3. by manufacturers of equipment furnished under the Contract Documents;
 4. for testing, adjusting, and balancing of mechanical, electrical, and other equipment to be incorporated into the Work; and
 5. for acceptance of materials, mix designs, or equipment submitted for approval prior to Contractor's purchase thereof for incorporation in the Work.

Such inspections and tests will be performed by independent inspectors, testing laboratories, or other qualified individuals or entities acceptable to Owner and Engineer.

- E. If the Contract Documents require the Work (or part thereof) to be approved by Owner, Engineer, or another designated individual or entity, then Contractor shall assume full responsibility for arranging and obtaining such approvals.
- F. If any Work (or the work of others) that is to be inspected, tested, or approved is covered by Contractor without written concurrence of Engineer, Contractor shall, if requested by Engineer, uncover such Work for observation. Such uncovering will be at Contractor's expense unless Contractor had given Engineer timely notice of Contractor's intention to cover the same and Engineer had not acted with reasonable promptness in response to such notice.

14.03 *Defective Work*

- A. *Contractor's Obligation:* It is Contractor's obligation to assure that the Work is not defective.
- B. *Engineer's Authority:* Engineer has the authority to determine whether Work is defective, and to reject defective Work.
- C. *Notice of Defects:* Prompt written notice of all defective Work of which Owner or Engineer has actual knowledge will be given to Contractor.
- D. *Correction, or Removal and Replacement:* Promptly after receipt of written notice of defective Work, Contractor shall correct all such defective Work, whether or not fabricated, installed, or completed, or, if Engineer has rejected the defective Work, remove it from the Project and replace it with Work that is not defective.
- E. *Preservation of Warranties:* When correcting defective Work, Contractor shall take no action that would void or otherwise impair Owner's special warranty and guarantee, if any, on said Work.
- F. *Costs and Damages:* In addition to its correction, removal, and replacement obligations with respect to defective Work, Contractor shall pay all claims, costs, losses, and damages arising out of or relating to defective Work, including but not limited to the cost of the inspection, testing, correction, removal, replacement, or reconstruction of such defective Work, fines levied against Owner by governmental authorities because the Work is defective, and the costs of repair or replacement of work of others resulting from defective Work. Prior to final payment, if Owner and Contractor are unable to agree as to the measure of such claims, costs,

losses, and damages resulting from defective Work, then Owner may impose a reasonable set-off against payments due under Article 15.

14.04 *Acceptance of Defective Work*

- A. If, instead of requiring correction or removal and replacement of defective Work, Owner prefers to accept it, Owner may do so (subject, if such acceptance occurs prior to final payment, to Engineer's confirmation that such acceptance is in general accord with the design intent and applicable engineering principles, and will not endanger public safety). Contractor shall pay all claims, costs, losses, and damages attributable to Owner's evaluation of and determination to accept such defective Work (such costs to be approved by Engineer as to reasonableness), and for the diminished value of the Work to the extent not otherwise paid by Contractor. If any such acceptance occurs prior to final payment, the necessary revisions in the Contract Documents with respect to the Work will be incorporated in a Change Order. If the parties are unable to agree as to the decrease in the Contract Price, reflecting the diminished value of Work so accepted, then Owner may impose a reasonable set-off against payments due under Article 15. If the acceptance of defective Work occurs after final payment, Contractor shall pay an appropriate amount to Owner.

14.05 *Uncovering Work*

- A. Engineer has the authority to require additional inspection or testing of the Work, whether or not the Work is fabricated, installed, or completed.
- B. If any Work is covered contrary to the written request of Engineer, then Contractor shall, if requested by Engineer, uncover such Work for Engineer's observation, and then replace the covering, all at Contractor's expense.
- C. If Engineer considers it necessary or advisable that covered Work be observed by Engineer or inspected or tested by others, then Contractor, at Engineer's request, shall uncover, expose, or otherwise make available for observation, inspection, or testing as Engineer may require, that portion of the Work in question, and provide all necessary labor, material, and equipment.
 - 1. If it is found that the uncovered Work is defective, Contractor shall be responsible for all claims, costs, losses, and damages arising out of or relating to such uncovering, exposure, observation, inspection, and testing, and of satisfactory replacement or reconstruction (including but not limited to all costs of repair or replacement of work of others); and pending Contractor's full discharge of this responsibility the Owner shall be entitled to impose a reasonable set-off against payments due under Article 15.
 - 2. If the uncovered Work is not found to be defective, Contractor shall be allowed an increase in the Contract Price or an extension of the Contract Times, directly attributable to such uncovering, exposure, observation, inspection, testing, replacement, and reconstruction. If the parties are unable to agree as to the amount or extent thereof, then Contractor may submit a Change Proposal within 30 days of the determination that the Work is not defective.

14.06 *Owner May Stop the Work*

- A. If the Work is defective, or Contractor fails to supply sufficient skilled workers or suitable materials or equipment, or fails to perform the Work in such a way that the completed Work will conform to the Contract Documents, then Owner may order Contractor to stop the Work,

or any portion thereof, until the cause for such order has been eliminated; however, this right of Owner to stop the Work will not give rise to any duty on the part of Owner to exercise this right for the benefit of Contractor, any Subcontractor, any Supplier, any other individual or entity, or any surety for, or employee or agent of any of them.

14.07 Owner May Correct Defective Work

- A. If Contractor fails within a reasonable time after written notice from Engineer to correct defective Work, or to remove and replace defective Work as required by Engineer, then Owner may, after 7 days' written notice to Contractor, correct or remedy any such deficiency.
- B. In exercising the rights and remedies under this Paragraph 14.07, Owner shall proceed expeditiously. In connection with such corrective or remedial action, Owner may exclude Contractor from all or part of the Site, take possession of all or part of the Work and suspend Contractor's services related thereto, and incorporate in the Work all materials and equipment stored at the Site or for which Owner has paid Contractor but which are stored elsewhere. Contractor shall allow Owner, Owner's representatives, agents and employees, Owner's other contractors, and Engineer and Engineer's consultants access to the Site to enable Owner to exercise the rights and remedies under this paragraph.
- C. All claims, costs, losses, and damages incurred or sustained by Owner in exercising the rights and remedies under this Paragraph 14.07 will be charged against Contractor as set-offs against payments due under Article 15. Such claims, costs, losses and damages will include but not be limited to all costs of repair, or replacement of work of others destroyed or damaged by correction, removal, or replacement of Contractor's defective Work.
- D. Contractor shall not be allowed an extension of the Contract Times because of any delay in the performance of the Work attributable to the exercise by Owner of Owner's rights and remedies under this Paragraph 14.07.

ARTICLE 15—PAYMENTS TO CONTRACTOR; SET-OFFS; COMPLETION; CORRECTION PERIOD

15.01 Progress Payments

- A. *Basis for Progress Payments:* The Schedule of Values established as provided in Article 2 will serve as the basis for progress payments and will be incorporated into a form of Application for Payment acceptable to Engineer. Progress payments for Unit Price Work will be based on the number of units completed during the pay period, as determined under the provisions of Paragraph 13.03. Progress payments for cost-based Work will be based on Cost of the Work completed by Contractor during the pay period.
- B. *Applications for Payments*
 - 1. At least 20 days before the date established in the Agreement for each progress payment (but not more often than once a month), Contractor shall submit to Engineer for review an Application for Payment filled out and signed by Contractor covering the Work completed as of the date of the Application and accompanied by such supporting documentation as is required by the Contract Documents.
 - 2. If payment is requested on the basis of materials and equipment not incorporated in the Work but delivered and suitably stored at the Site or at another location agreed to in writing, the Application for Payment must also be accompanied by: (a) a bill of sale, invoice, copies of subcontract or purchase order payments, or other documentation

establishing full payment by Contractor for the materials and equipment; (b) at Owner's request, documentation warranting that Owner has received the materials and equipment free and clear of all Liens; and (c) evidence that the materials and equipment are covered by appropriate property insurance, a warehouse bond, or other arrangements to protect Owner's interest therein, all of which must be satisfactory to Owner.

3. Beginning with the second Application for Payment, each Application must include an affidavit of Contractor stating that all previous progress payments received by Contractor have been applied to discharge Contractor's legitimate obligations associated with prior Applications for Payment.
4. The amount of retainage with respect to progress payments will be as stipulated in the Agreement.

C. *Review of Applications*

1. Engineer will, within 10 days after receipt of each Application for Payment, including each resubmittal, either indicate in writing a recommendation of payment and present the Application to Owner, or return the Application to Contractor indicating in writing Engineer's reasons for refusing to recommend payment. In the latter case, Contractor may make the necessary corrections and resubmit the Application.
2. Engineer's recommendation of any payment requested in an Application for Payment will constitute a representation by Engineer to Owner, based on Engineer's observations of the executed Work as an experienced and qualified design professional, and on Engineer's review of the Application for Payment and the accompanying data and schedules, that to the best of Engineer's knowledge, information and belief:
 - a. the Work has progressed to the point indicated;
 - b. the quality of the Work is generally in accordance with the Contract Documents (subject to an evaluation of the Work as a functioning whole prior to or upon Substantial Completion, the results of any subsequent tests called for in the Contract Documents, a final determination of quantities and classifications for Unit Price Work under Paragraph 13.03, and any other qualifications stated in the recommendation); and
 - c. the conditions precedent to Contractor's being entitled to such payment appear to have been fulfilled in so far as it is Engineer's responsibility to observe the Work.
3. By recommending any such payment Engineer will not thereby be deemed to have represented that:
 - a. inspections made to check the quality or the quantity of the Work as it has been performed have been exhaustive, extended to every aspect of the Work in progress, or involved detailed inspections of the Work beyond the responsibilities specifically assigned to Engineer in the Contract; or
 - b. there may not be other matters or issues between the parties that might entitle Contractor to be paid additionally by Owner or entitle Owner to withhold payment to Contractor.

4. Neither Engineer's review of Contractor's Work for the purposes of recommending payments nor Engineer's recommendation of any payment, including final payment, will impose responsibility on Engineer:
 - a. to supervise, direct, or control the Work;
 - b. for the means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto;
 - c. for Contractor's failure to comply with Laws and Regulations applicable to Contractor's performance of the Work;
 - d. to make any examination to ascertain how or for what purposes Contractor has used the money paid by Owner; or
 - e. to determine that title to any of the Work, materials, or equipment has passed to Owner free and clear of any Liens.
5. Engineer may refuse to recommend the whole or any part of any payment if, in Engineer's opinion, it would be incorrect to make the representations to Owner stated in Paragraph 15.01.C.2.
6. Engineer will recommend reductions in payment (set-offs) necessary in Engineer's opinion to protect Owner from loss because:
 - a. the Work is defective, requiring correction or replacement;
 - b. the Contract Price has been reduced by Change Orders;
 - c. Owner has been required to correct defective Work in accordance with Paragraph 14.07, or has accepted defective Work pursuant to Paragraph 14.04;
 - d. Owner has been required to remove or remediate a Hazardous Environmental Condition for which Contractor is responsible; or
 - e. Engineer has actual knowledge of the occurrence of any of the events that would constitute a default by Contractor and therefore justify termination for cause under the Contract Documents.

D. *Payment Becomes Due*

1. Ten days after presentation of the Application for Payment to Owner with Engineer's recommendation, the amount recommended (subject to any Owner set-offs) will become due, and when due will be paid by Owner to Contractor.

E. *Reductions in Payment by Owner*

1. In addition to any reductions in payment (set-offs) recommended by Engineer, Owner is entitled to impose a set-off against payment based on any of the following:
 - a. Claims have been made against Owner based on Contractor's conduct in the performance or furnishing of the Work, or Owner has incurred costs, losses, or damages resulting from Contractor's conduct in the performance or furnishing of the Work, including but not limited to claims, costs, losses, or damages from workplace injuries, adjacent property damage, non-compliance with Laws and Regulations, and patent infringement;

- b. Contractor has failed to take reasonable and customary measures to avoid damage, delay, disruption, and interference with other work at or adjacent to the Site;
 - c. Contractor has failed to provide and maintain required bonds or insurance;
 - d. Owner has been required to remove or remediate a Hazardous Environmental Condition for which Contractor is responsible;
 - e. Owner has incurred extra charges or engineering costs related to submittal reviews, evaluations of proposed substitutes, tests and inspections, or return visits to manufacturing or assembly facilities;
 - f. The Work is defective, requiring correction or replacement;
 - g. Owner has been required to correct defective Work in accordance with Paragraph 14.07, or has accepted defective Work pursuant to Paragraph 14.04;
 - h. The Contract Price has been reduced by Change Orders;
 - i. An event has occurred that would constitute a default by Contractor and therefore justify a termination for cause;
 - j. Liquidated or other damages have accrued as a result of Contractor's failure to achieve Milestones, Substantial Completion, or final completion of the Work;
 - k. Liens have been filed in connection with the Work, except where Contractor has delivered a specific bond satisfactory to Owner to secure the satisfaction and discharge of such Liens; or
 - l. Other items entitle Owner to a set-off against the amount recommended.
2. If Owner imposes any set-off against payment, whether based on its own knowledge or on the written recommendations of Engineer, Owner will give Contractor immediate written notice (with a copy to Engineer) stating the reasons for such action and the specific amount of the reduction, and promptly pay Contractor any amount remaining after deduction of the amount so withheld. Owner shall promptly pay Contractor the amount so withheld, or any adjustment thereto agreed to by Owner and Contractor, if Contractor remedies the reasons for such action. The reduction imposed will be binding on Contractor unless it duly submits a Change Proposal contesting the reduction.
 3. Upon a subsequent determination that Owner's refusal of payment was not justified, the amount wrongfully withheld will be treated as an amount due as determined by Paragraph 15.01.D.1 and subject to interest as provided in the Agreement.

15.02 *Contractor's Warranty of Title*

- A. Contractor warrants and guarantees that title to all Work, materials, and equipment furnished under the Contract will pass to Owner free and clear of (1) all Liens and other title defects, and (2) all patent, licensing, copyright, or royalty obligations, no later than 7 days after the time of payment by Owner.

15.03 *Substantial Completion*

- A. When Contractor considers the entire Work ready for its intended use Contractor shall notify Owner and Engineer in writing that the entire Work is substantially complete and request that Engineer issue a certificate of Substantial Completion. Contractor shall at the same time

submit to Owner and Engineer an initial draft of punch list items to be completed or corrected before final payment.

- B. Promptly after Contractor's notification, Owner, Contractor, and Engineer shall make an inspection of the Work to determine the status of completion. If Engineer does not consider the Work substantially complete, Engineer will notify Contractor in writing giving the reasons therefor.
- C. If Engineer considers the Work substantially complete, Engineer will deliver to Owner a preliminary certificate of Substantial Completion which will fix the date of Substantial Completion. Engineer shall attach to the certificate a punch list of items to be completed or corrected before final payment. Owner shall have 7 days after receipt of the preliminary certificate during which to make written objection to Engineer as to any provisions of the certificate or attached punch list. If, after considering the objections to the provisions of the preliminary certificate, Engineer concludes that the Work is not substantially complete, Engineer will, within 14 days after submission of the preliminary certificate to Owner, notify Contractor in writing that the Work is not substantially complete, stating the reasons therefor. If Owner does not object to the provisions of the certificate, or if despite consideration of Owner's objections Engineer concludes that the Work is substantially complete, then Engineer will, within said 14 days, execute and deliver to Owner and Contractor a final certificate of Substantial Completion (with a revised punch list of items to be completed or corrected) reflecting such changes from the preliminary certificate as Engineer believes justified after consideration of any objections from Owner.
- D. At the time of receipt of the preliminary certificate of Substantial Completion, Owner and Contractor will confer regarding Owner's use or occupancy of the Work following Substantial Completion, review the builder's risk insurance policy with respect to the end of the builder's risk coverage, and confirm the transition to coverage of the Work under a permanent property insurance policy held by Owner. Unless Owner and Contractor agree otherwise in writing, Owner shall bear responsibility for security, operation, protection of the Work, property insurance, maintenance, heat, and utilities upon Owner's use or occupancy of the Work.
- E. After Substantial Completion the Contractor shall promptly begin work on the punch list of items to be completed or corrected prior to final payment. In appropriate cases Contractor may submit monthly Applications for Payment for completed punch list items, following the progress payment procedures set forth above.
- F. Owner shall have the right to exclude Contractor from the Site after the date of Substantial Completion subject to allowing Contractor reasonable access to remove its property and complete or correct items on the punch list.

15.04 *Partial Use or Occupancy*

- A. Prior to Substantial Completion of all the Work, Owner may use or occupy any substantially completed part of the Work which has specifically been identified in the Contract Documents, or which Owner, Engineer, and Contractor agree constitutes a separately functioning and usable part of the Work that can be used by Owner for its intended purpose without

significant interference with Contractor's performance of the remainder of the Work, subject to the following conditions:

1. At any time, Owner may request in writing that Contractor permit Owner to use or occupy any such part of the Work that Owner believes to be substantially complete. If and when Contractor agrees that such part of the Work is substantially complete, Contractor, Owner, and Engineer will follow the procedures of Paragraph 15.03.A through 15.03.E for that part of the Work.
2. At any time, Contractor may notify Owner and Engineer in writing that Contractor considers any such part of the Work substantially complete and request Engineer to issue a certificate of Substantial Completion for that part of the Work.
3. Within a reasonable time after either such request, Owner, Contractor, and Engineer shall make an inspection of that part of the Work to determine its status of completion. If Engineer does not consider that part of the Work to be substantially complete, Engineer will notify Owner and Contractor in writing giving the reasons therefor. If Engineer considers that part of the Work to be substantially complete, the provisions of Paragraph 15.03 will apply with respect to certification of Substantial Completion of that part of the Work and the division of responsibility in respect thereof and access thereto.
4. No use or occupancy or separate operation of part of the Work may occur prior to compliance with the requirements of Paragraph 6.04 regarding builder's risk or other property insurance.

15.05 *Final Inspection*

- A. Upon written notice from Contractor that the entire Work or an agreed portion thereof is complete, Engineer will promptly make a final inspection with Owner and Contractor and will notify Contractor in writing of all particulars in which this inspection reveals that the Work, or agreed portion thereof, is incomplete or defective. Contractor shall immediately take such measures as are necessary to complete such Work or remedy such deficiencies.

15.06 *Final Payment*

A. *Application for Payment*

1. After Contractor has, in the opinion of Engineer, satisfactorily completed all corrections identified during the final inspection and has delivered, in accordance with the Contract Documents, all maintenance and operating instructions, schedules, guarantees, bonds, certificates or other evidence of insurance, certificates of inspection, annotated record documents (as provided in Paragraph 7.12), and other documents, Contractor may make application for final payment.
2. The final Application for Payment must be accompanied (except as previously delivered) by:
 - a. all documentation called for in the Contract Documents;
 - b. consent of the surety, if any, to final payment;
 - c. satisfactory evidence that all title issues have been resolved such that title to all Work, materials, and equipment has passed to Owner free and clear of any Liens or other title defects, or will so pass upon final payment.

- d. a list of all duly pending Change Proposals and Claims; and
 - e. complete and legally effective releases or waivers (satisfactory to Owner) of all Lien rights arising out of the Work, and of Liens filed in connection with the Work.
3. In lieu of the releases or waivers of Liens specified in Paragraph 15.06.A.2 and as approved by Owner, Contractor may furnish receipts or releases in full and an affidavit of Contractor that: (a) the releases and receipts include all labor, services, material, and equipment for which a Lien could be filed; and (b) all payrolls, material and equipment bills, and other indebtedness connected with the Work for which Owner might in any way be responsible, or which might in any way result in liens or other burdens on Owner's property, have been paid or otherwise satisfied. If any Subcontractor or Supplier fails to furnish such a release or receipt in full, Contractor may furnish a bond or other collateral satisfactory to Owner to indemnify Owner against any Lien, or Owner at its option may issue joint checks payable to Contractor and specified Subcontractors and Suppliers.
- B. *Engineer's Review of Final Application and Recommendation of Payment:* If, on the basis of Engineer's observation of the Work during construction and final inspection, and Engineer's review of the final Application for Payment and accompanying documentation as required by the Contract Documents, Engineer is satisfied that the Work has been completed and Contractor's other obligations under the Contract have been fulfilled, Engineer will, within 10 days after receipt of the final Application for Payment, indicate in writing Engineer's recommendation of final payment and present the final Application for Payment to Owner for payment. Such recommendation will account for any set-offs against payment that are necessary in Engineer's opinion to protect Owner from loss for the reasons stated above with respect to progress payments. Otherwise, Engineer will return the Application for Payment to Contractor, indicating in writing the reasons for refusing to recommend final payment, in which case Contractor shall make the necessary corrections and resubmit the Application for Payment.
- C. *Notice of Acceptability:* In support of its recommendation of payment of the final Application for Payment, Engineer will also give written notice to Owner and Contractor that the Work is acceptable, subject to stated limitations in the notice and to the provisions of Paragraph 15.07.
- D. *Completion of Work:* The Work is complete (subject to surviving obligations) when it is ready for final payment as established by the Engineer's written recommendation of final payment and issuance of notice of the acceptability of the Work.
- E. *Final Payment Becomes Due:* Upon receipt from Engineer of the final Application for Payment and accompanying documentation, Owner shall set off against the amount recommended by Engineer for final payment any further sum to which Owner is entitled, including but not limited to set-offs for liquidated damages and set-offs allowed under the provisions of this Contract with respect to progress payments. Owner shall pay the resulting balance due to Contractor within 30 days of Owner's receipt of the final Application for Payment from Engineer.

15.07 *Waiver of Claims*

- A. By making final payment, Owner waives its claim or right to liquidated damages or other damages for late completion by Contractor, except as set forth in an outstanding Claim,

appeal under the provisions of Article 17, set-off, or express reservation of rights by Owner. Owner reserves all other claims or rights after final payment.

- B. The acceptance of final payment by Contractor will constitute a waiver by Contractor of all claims and rights against Owner other than those pending matters that have been duly submitted as a Claim, or appealed under the provisions of Article 17.

15.08 *Correction Period*

- A. If within one year after the date of Substantial Completion (or such longer period of time as may be prescribed by the Supplementary Conditions or the terms of any applicable special guarantee required by the Contract Documents), Owner gives Contractor written notice that any Work has been found to be defective, or that Contractor's repair of any damages to the Site or adjacent areas has been found to be defective, then after receipt of such notice of defect Contractor shall promptly, without cost to Owner and in accordance with Owner's written instructions:
 - 1. correct the defective repairs to the Site or such adjacent areas;
 - 2. correct such defective Work;
 - 3. remove the defective Work from the Project and replace it with Work that is not defective, if the defective Work has been rejected by Owner, and
 - 4. satisfactorily correct or repair or remove and replace any damage to other Work, to the work of others, or to other land or areas resulting from the corrective measures.
- B. Owner shall give any such notice of defect within 60 days of the discovery that such Work or repairs is defective. If such notice is given within such 60 days but after the end of the correction period, the notice will be deemed a notice of defective Work under Paragraph 7.17.B.
- C. If, after receipt of a notice of defect within 60 days and within the correction period, Contractor does not promptly comply with the terms of Owner's written instructions, or in an emergency where delay would cause serious risk of loss or damage, Owner may have the defective Work corrected or repaired or may have the rejected Work removed and replaced. Contractor shall pay all costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to such correction or repair or such removal and replacement (including but not limited to all costs of repair or replacement of work of others). Contractor's failure to pay such costs, losses, and damages within 10 days of invoice from Owner will be deemed the start of an event giving rise to a Claim under Paragraph 12.01.B, such that any related Claim must be brought within 30 days of the failure to pay.
- D. In special circumstances where a particular item of equipment is placed in continuous service before Substantial Completion of all the Work, the correction period for that item may start to run from an earlier date if so provided in the Specifications.
- E. Where defective Work (and damage to other Work resulting therefrom) has been corrected or removed and replaced under this paragraph, the correction period hereunder with respect to such Work will be extended for an additional period of one year after such correction or removal and replacement has been satisfactorily completed.

- F. Contractor's obligations under this paragraph are in addition to all other obligations and warranties. The provisions of this paragraph are not to be construed as a substitute for, or a waiver of, the provisions of any applicable statute of limitation or repose.

ARTICLE 16—SUSPENSION OF WORK AND TERMINATION

16.01 *Owner May Suspend Work*

- A. At any time and without cause, Owner may suspend the Work or any portion thereof for a period of not more than 90 consecutive days by written notice to Contractor and Engineer. Such notice will fix the date on which Work will be resumed. Contractor shall resume the Work on the date so fixed. Contractor shall be entitled to an adjustment in the Contract Price or an extension of the Contract Times directly attributable to any such suspension. Any Change Proposal seeking such adjustments must be submitted no later than 30 days after the date fixed for resumption of Work.

16.02 *Owner May Terminate for Cause*

- A. The occurrence of any one or more of the following events will constitute a default by Contractor and justify termination for cause:
 - 1. Contractor's persistent failure to perform the Work in accordance with the Contract Documents (including, but not limited to, failure to supply sufficient skilled workers or suitable materials or equipment, or failure to adhere to the Progress Schedule);
 - 2. Failure of Contractor to perform or otherwise to comply with a material term of the Contract Documents;
 - 3. Contractor's disregard of Laws or Regulations of any public body having jurisdiction; or
 - 4. Contractor's repeated disregard of the authority of Owner or Engineer.
- B. If one or more of the events identified in Paragraph 16.02.A occurs, then after giving Contractor (and any surety) 10 days' written notice that Owner is considering a declaration that Contractor is in default and termination of the Contract, Owner may proceed to:
 - 1. declare Contractor to be in default, and give Contractor (and any surety) written notice that the Contract is terminated; and
 - 2. enforce the rights available to Owner under any applicable performance bond.
- C. Subject to the terms and operation of any applicable performance bond, if Owner has terminated the Contract for cause, Owner may exclude Contractor from the Site, take possession of the Work, incorporate in the Work all materials and equipment stored at the Site or for which Owner has paid Contractor but which are stored elsewhere, and complete the Work as Owner may deem expedient.
- D. Owner may not proceed with termination of the Contract under Paragraph 16.02.B if Contractor within 7 days of receipt of notice of intent to terminate begins to correct its failure to perform and proceeds diligently to cure such failure.
- E. If Owner proceeds as provided in Paragraph 16.02.B, Contractor shall not be entitled to receive any further payment until the Work is completed. If the unpaid balance of the Contract Price exceeds the cost to complete the Work, including all related claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects,

attorneys, and other professionals) sustained by Owner, such excess will be paid to Contractor. If the cost to complete the Work including such related claims, costs, losses, and damages exceeds such unpaid balance, Contractor shall pay the difference to Owner. Such claims, costs, losses, and damages incurred by Owner will be reviewed by Engineer as to their reasonableness and, when so approved by Engineer, incorporated in a Change Order. When exercising any rights or remedies under this paragraph, Owner shall not be required to obtain the lowest price for the Work performed.

- F. Where Contractor's services have been so terminated by Owner, the termination will not affect any rights or remedies of Owner against Contractor then existing or which may thereafter accrue, or any rights or remedies of Owner against Contractor or any surety under any payment bond or performance bond. Any retention or payment of money due Contractor by Owner will not release Contractor from liability.
- G. If and to the extent that Contractor has provided a performance bond under the provisions of Paragraph 6.01.A, the provisions of that bond will govern over any inconsistent provisions of Paragraphs 16.02.B and 16.02.D.

16.03 *Owner May Terminate for Convenience*

- A. Upon 7 days' written notice to Contractor and Engineer, Owner may, without cause and without prejudice to any other right or remedy of Owner, terminate the Contract. In such case, Contractor shall be paid for (without duplication of any items):
 - 1. completed and acceptable Work executed in accordance with the Contract Documents prior to the effective date of termination, including fair and reasonable sums for overhead and profit on such Work;
 - 2. expenses sustained prior to the effective date of termination in performing services and furnishing labor, materials, or equipment as required by the Contract Documents in connection with uncompleted Work, plus fair and reasonable sums for overhead and profit on such expenses; and
 - 3. other reasonable expenses directly attributable to termination, including costs incurred to prepare a termination for convenience cost proposal.
- B. Contractor shall not be paid for any loss of anticipated profits or revenue, post-termination overhead costs, or other economic loss arising out of or resulting from such termination.

16.04 *Contractor May Stop Work or Terminate*

- A. If, through no act or fault of Contractor, (1) the Work is suspended for more than 90 consecutive days by Owner or under an order of court or other public authority, or (2) Engineer fails to act on any Application for Payment within 30 days after it is submitted, or (3) Owner fails for 30 days to pay Contractor any sum finally determined to be due, then Contractor may, upon 7 days' written notice to Owner and Engineer, and provided Owner or Engineer do not remedy such suspension or failure within that time, terminate the contract and recover from Owner payment on the same terms as provided in Paragraph 16.03.
- B. In lieu of terminating the Contract and without prejudice to any other right or remedy, if Engineer has failed to act on an Application for Payment within 30 days after it is submitted, or Owner has failed for 30 days to pay Contractor any sum finally determined to be due, Contractor may, 7 days after written notice to Owner and Engineer, stop the Work until payment is made of all such amounts due Contractor, including interest thereon. The

provisions of this paragraph are not intended to preclude Contractor from submitting a Change Proposal for an adjustment in Contract Price or Contract Times or otherwise for expenses or damage directly attributable to Contractor's stopping the Work as permitted by this paragraph.

ARTICLE 17—FINAL RESOLUTION OF DISPUTES

17.01 *Methods and Procedures*

- A. *Disputes Subject to Final Resolution:* The following disputed matters are subject to final resolution under the provisions of this article:
1. A timely appeal of an approval in part and denial in part of a Claim, or of a denial in full, pursuant to Article 12; and
 2. Disputes between Owner and Contractor concerning the Work, or obligations under the Contract Documents, that arise after final payment has been made.
- B. *Final Resolution of Disputes:* For any dispute subject to resolution under this article, Owner or Contractor may:
1. elect in writing to invoke the dispute resolution process provided for in the Supplementary Conditions;
 2. agree with the other party to submit the dispute to another dispute resolution process; or
 3. if no dispute resolution process is provided for in the Supplementary Conditions or mutually agreed to, give written notice to the other party of the intent to submit the dispute to a court of competent jurisdiction.

ARTICLE 18—MISCELLANEOUS

18.01 *Giving Notice*

- A. Whenever any provision of the Contract requires the giving of written notice to Owner, Engineer, or Contractor, it will be deemed to have been validly given only if delivered:
1. in person, by a commercial courier service or otherwise, to the recipient's place of business;
 2. by registered or certified mail, postage prepaid, to the recipient's place of business; or
 3. by e-mail to the recipient, with the words "Formal Notice" or similar in the e-mail's subject line.

18.02 *Computation of Times*

- A. When any period of time is referred to in the Contract by days, it will be computed to exclude the first and include the last day of such period. If the last day of any such period falls on a Saturday or Sunday or on a day made a legal holiday by the law of the applicable jurisdiction, such day will be omitted from the computation.

18.03 *Cumulative Remedies*

- A. The duties and obligations imposed by these General Conditions and the rights and remedies available hereunder to the parties hereto are in addition to, and are not to be construed in any way as a limitation of, any rights and remedies available to any or all of them which are otherwise imposed or available by Laws or Regulations, by special warranty or guarantee, or by other provisions of the Contract. The provisions of this paragraph will be as effective as if repeated specifically in the Contract Documents in connection with each particular duty, obligation, right, and remedy to which they apply.

18.04 *Limitation of Damages*

- A. With respect to any and all Change Proposals, Claims, disputes subject to final resolution, and other matters at issue, neither Owner nor Engineer, nor any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors, shall be liable to Contractor for any claims, costs, losses, or damages sustained by Contractor on or in connection with any other project or anticipated project.

18.05 *No Waiver*

- A. A party's non-enforcement of any provision will not constitute a waiver of that provision, nor will it affect the enforceability of that provision or of the remainder of this Contract.

18.06 *Survival of Obligations*

- A. All representations, indemnifications, warranties, and guarantees made in, required by, or given in accordance with the Contract, as well as all continuing obligations indicated in the Contract, will survive final payment, completion, and acceptance of the Work or termination of the Contract or of the services of Contractor.

18.07 *Controlling Law*

- A. This Contract is to be governed by the law of the state in which the Project is located.

18.08 *Assignment of Contract*

- A. Unless expressly agreed to elsewhere in the Contract, no assignment by a party to this Contract of any rights under or interests in the Contract will be binding on the other party without the written consent of the party sought to be bound; and, specifically but without limitation, money that may become due and money that is due may not be assigned without such consent (except to the extent that the effect of this restriction may be limited by law), and unless specifically stated to the contrary in any written consent to an assignment, no assignment will release or discharge the assignor from any duty or responsibility under the Contract.

18.09 *Successors and Assigns*

- A. Owner and Contractor each binds itself, its successors, assigns, and legal representatives to the other party hereto, its successors, assigns, and legal representatives in respect to all covenants, agreements, and obligations contained in the Contract Documents.

18.10 *Headings*

- A. Article and paragraph headings are inserted for convenience only and do not constitute parts of these General Conditions.

This document has important legal consequences; consultation with an attorney is encouraged with respect to its use or modification. This document should be adapted to the particular circumstances of the contemplated Project and the controlling Laws and Regulations.

SUPPLEMENTARY CONDITIONS OF THE CONSTRUCTION CONTRACT

Prepared By



Endorsed By



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SUPPLEMENTARY CONDITIONS OF THE CONSTRUCTION CONTRACT

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SUPPLEMENTARY CONDITIONS OF THE CONSTRUCTION CONTRACT

These Supplementary Conditions amend or supplement EJCDC® C-700, Standard General Conditions of the Construction Contract (2018). The General Conditions remain in full force and effect except as amended.

The terms used in these Supplementary Conditions have the meanings stated in the General Conditions. Additional terms used in these Supplementary Conditions have the meanings stated below, which are applicable to both the singular and plural thereof.

The address system used in these Supplementary Conditions is the same as the address system used in the General Conditions, with the prefix "SC" added—for example, "Paragraph SC-4.05."

ARTICLE 1—DEFINITIONS AND TERMINOLOGY

No suggested Supplementary Conditions in this Article.

ARTICLE 2—PRELIMINARY MATTERS

2.01 *Delivery of Bonds and Evidence of Insurance*

SC-2.01 Delete Paragraphs 2.01.B. and C. in their entirety and insert the following in their place:

- B. *Evidence of Contractor's Insurance:* When Contractor delivers the signed counterparts of the Agreement to Owner, Contractor shall also deliver to Owner copies of the policies (including all endorsements, and identification of applicable self-insured retentions and deductibles) of insurance required to be provided by Contractor in this Contract. Contractor may block out (redact) any confidential premium or pricing information contained in any policy or endorsement furnished under this provision.
- C. *Evidence of Owner's Insurance:* After receipt from Contractor of the signed counterparts of the Agreement and all required bonds and insurance documentation, Owner shall promptly deliver to Contractor copies of the policies of insurance to be provided by Owner in this Contract (if any). Owner may block out (redact) any confidential premium or pricing information contained in any policy or endorsement furnished under this provision.

2.02 *Copies of Documents*

SC-2.02 Amend the first sentence of Paragraph 2.02.A. to read as follows:

Owner shall furnish to Contractor **THREE** printed copies of the Contract Documents (including one fully signed counterpart of the Agreement), and **ONE** in electronic portable document format (PDF).

2.06 *Electronic Transmittals*

SC-2.06 Delete Paragraphs 2.06.B and 2.06.C in their entirety and insert the following in their place:

- B. *Electronic Documents Protocol:* The parties shall conform to the following provisions in Paragraphs 2.06.B and 2.06.C, together referred to as the Electronic Documents Protocol ("EDP" or "Protocol") for exchange of electronic transmittals.

1. *Basic Requirements*

- a. To the fullest extent practical, the parties agree to and will transmit and accept Electronic Documents in an electronic or digital format using the procedures described in this Protocol. Use of the Electronic Documents and any information contained therein is subject to the requirements of this Protocol and other provisions of the Contract.
- b. The contents of the information in any Electronic Document will be the responsibility of the transmitting party.
- c. Electronic Documents as exchanged by this Protocol may be used in the same manner as the printed versions of the same documents that are exchanged using non-electronic format and methods, subject to the same governing requirements, limitations, and restrictions, set forth in the Contract Documents.
- d. Except as otherwise explicitly stated herein, the terms of this Protocol will be incorporated into any other agreement or subcontract between a party and any third party for any portion of the Work on the Project, or any Project-related services, where that third party is, either directly or indirectly, required to exchange Electronic Documents with a party or with Engineer. Nothing herein will modify the requirements of the Contract regarding communications between and among the parties and their subcontractors and consultants.
- e. When transmitting Electronic Documents, the transmitting party makes no representations as to long term compatibility, usability, or readability of the items resulting from the receiving party's use of software application packages, operating systems, or computer hardware differing from those established in this Protocol.
- f. Nothing herein negates any obligation 1) in the Contract to create, provide, or maintain an original printed record version of Drawings and Specifications, signed and sealed according to applicable Laws and Regulations; 2) to comply with any applicable Law or Regulation governing the signing and sealing of design documents or the signing and electronic transmission of any other documents; or 3) to comply with the notice requirements of Paragraph 18.01 of the General Conditions.

2. *System Infrastructure for Electronic Document Exchange*

- a. The contractor shall provide electronic documents in a format matching the stated software of each deliverable in electronic format.
 - 1) The maximum size of an email attachment for exchange of Electronic Documents under this EDP is 10.0 MB. Attachments larger than that may be exchanged using large file transfer functions or physical media.
 - 2) Each Party assumes full and complete responsibility for any and all of its own costs, delays, deficiencies, and errors associated with converting, translating, updating, verifying, licensing, or otherwise enabling its System Infrastructure, including operating systems and software, for use with respect to this EDP.
- b. Each party is responsible for its own system operations, security, back-up, archiving, audits, printing resources, and other Information Technology ("IT") for

maintaining operations of its System Infrastructure during the Project, including coordination with the party's individual(s) or entity responsible for managing its System Infrastructure and capable of addressing routine communications and other IT issues affecting the exchange of Electronic Documents.

- c. Each party will operate and maintain industry-standard, industry-accepted, ISO-standard, commercial-grade security software and systems that are intended to protect the other party from: software viruses and other malicious software like worms, trojans, adware; data breaches; loss of confidentiality; and other threats in the transmission to or storage of information from the other parties, including transmission of Electronic Documents by physical media such as CD/DVD/flash drive/hard drive. To the extent that a party maintains and operates such security software and systems, it shall not be liable to the other party for any breach of system security.
- d. In the case of disputes, conflicts, or modifications to the EDP required to address issues affecting System Infrastructure, the parties shall cooperatively resolve the issues; but, failing resolution, the Owner is authorized to make and require reasonable and necessary changes to the EDP to effectuate its original intent. If the changes cause additional cost or time to Contractor, not reasonably anticipated under the original EDP, Contractor may seek an adjustment in price or time under the appropriate process in the Contract.
- e. Each party is responsible for its own back-up and archive of documents sent and received during the term of the contract under this EDP, unless this EDP establishes a Project document archive, either as part of a mandatory Project website or other communications protocol, upon which the parties may rely for document archiving during the specified term of operation of such Project document archive. Further, each party remains solely responsible for its own post-Project back-up and archive of Project documents after the term of the Contract, or after termination of the Project document archive, if one is established, for as long as required by the Contract and as each party deems necessary for its own purposes.
- f. If a receiving party receives an obviously corrupted, damaged, or unreadable Electronic Document, the receiving party will advise the sending party of the incomplete transmission.
- g. The parties will bring any non-conforming Electronic Documents into compliance with the EDP. The parties will attempt to complete a successful transmission of the Electronic Document or use an alternative delivery method to complete the communication.

C. *Software Requirements for Electronic Document Exchange; Limitations*

- 1. Each party will acquire the software and software licenses necessary to create and transmit Electronic Documents and to read and to use any Electronic Documents received from the other party (and if relevant from third parties), using the software formats required in this section of the EDP. Engineer shall dictate formats of certain electronic documents.

- a. Prior to using any updated version of the software required in this section for sending Electronic Documents to the other party, the originating party will first notify and receive concurrence from the other party for use of the updated version or adjust its transmission to comply with this EDP.
2. The parties agree not to intentionally edit, reverse engineer, decrypt, remove security or encryption features, or convert to another format for modification purposes any Electronic Document or information contained therein that was transmitted in a software data format, including Portable Document Format (PDF), intended by sender not to be modified, unless the receiving party obtains the permission of the sending party or is citing or quoting excerpts of the Electronic Document for Project purposes.
3. Software and data formats for exchange of Electronic Documents will conform to the requirements set forth in Exhibit A to this EDP, including software versions, if listed.

SC-2.06 Supplement Paragraph 2.06 of the General Conditions by adding the following paragraph:

D. *Requests by Contractor for Electronic Documents in Other Formats*

1. Release of any Electronic Document versions of the Project documents in formats other than those identified in the Electronic Documents Protocol (if any) or elsewhere in the Contract will be at the sole discretion of the Owner.
2. To extent determined by Owner, in its sole discretion, to be prudent and necessary, release of Electronic Documents versions of Project documents and other Project information requested by Contractor (“Request”) in formats other than those identified in the Electronic Documents Protocol (if any) or elsewhere in the Contract will be subject to the provisions of the Owner’s response to the Request, and to the following conditions to which Contractor agrees:
 - a. The content included in the Electronic Documents created by Engineer and covered by the Request was prepared by Engineer as an internal working document for Engineer’s purposes solely, and is being provided to Contractor on an “AS IS” basis without any warranties of any kind, including, but not limited to any implied warranties of fitness for any purpose. As such, Contractor is advised and acknowledges that the content may not be suitable for Contractor’s application, or may require substantial modification and independent verification by Contractor. The content may include limited resolution of models, not-to-scale schematic representations and symbols, use of notes to convey design concepts in lieu of accurate graphics, approximations, graphical simplifications, undocumented intermediate revisions, and other devices that may affect subsequent reuse.
 - b. Electronic Documents containing text, graphics, metadata, or other types of data that are provided by Engineer to Contractor under the request are only for convenience of Contractor. Any conclusion or information obtained or derived from such data will be at the Contractor’s sole risk and the Contractor waives any claims against Engineer or Owner arising from use of data in Electronic Documents covered by the Request.
 - c. Contractor shall indemnify and hold harmless Owner and Engineer and their subconsultants from all claims, damages, losses, and expenses, including attorneys’

fees and defense costs arising out of or resulting from Contractor's use, adaptation, or distribution of any Electronic Documents provided under the Request.

- d. Contractor agrees not to sell, copy, transfer, forward, give away or otherwise distribute this information (in source or modified file format) to any third party without the direct written authorization of Engineer, unless such distribution is specifically identified in the Request and is limited to Contractor's subcontractors. Contractor warrants that subsequent use by Contractor's subcontractors complies with all terms of the Contract Documents and Owner's response to Request.

ARTICLE 3—CONTRACT DOCUMENTS: INTENT, REQUIREMENTS, REUSE

3.01 Intent

SC-3.01 Delete Paragraph 3.01.C in its entirety.

ARTICLE 4—COMMENCEMENT AND PROGRESS OF THE WORK

4.05 Delays in Contractor's Progress

SC-4.05 Amend Paragraph 4.05.C by adding the following subparagraphs:

5. Weather-Related Delays

- a. If "abnormal weather conditions" as set forth in Paragraph 4.05.C.2 of the General Conditions are the basis for a request for an equitable adjustment in the Contract Times, such request must be documented by data substantiating each of the following: 1) that weather conditions were abnormal for the period of time in which the delay occurred, 2) that such weather conditions could not have been reasonably anticipated, and 3) that such weather conditions had an adverse effect on the Work as scheduled.
- b. The existence of abnormal weather conditions will be determined on a month-by-month basis in accordance with the following:
 - 1) Every workday on which one or more of the following conditions exist will be considered a "bad weather day":
 - i) Total precipitation (as rain equivalent) occurring between 7:00 p.m. on the preceding day (regardless of whether such preceding day is a workday) through 7:00 p.m. on the workday in question equals or exceeds 0.25" of precipitation (as rain equivalent, based on the snow/rain conversion indicated in the table entitled Foreseeable Bad Weather Days; such table is hereby incorporated in this SC-4.05.C by reference.
 - ii) Ambient outdoor air temperature at 11:00 a.m. is equal to or less than the following low temperature threshold: 0 degrees Fahrenheit; or, at 3:00 p.m. the ambient outdoor temperature is equal to or greater than the following high temperature threshold: 110 degrees Fahrenheit.
 - 2) Determination of actual bad weather days during performance of the Work will be based on the weather records measured and recorded by the National

Weather Service weather monitoring station at the National Weather Service monitoring station: Spencer WNG629 162.45.

ARTICLE 5—SITE, SUBSURFACE AND PHYSICAL CONDITIONS, HAZARDOUS ENVIRONMENTAL CONDITIONS

5.03 *Subsurface and Physical Conditions*

SC-5.03 Add the following new paragraphs immediately after Paragraph 5.03.D:

- E. The following table lists the reports of explorations and tests of subsurface conditions at or adjacent to the Site that contain Technical Data, and specifically identifies the Technical Data in the report upon which Contractor may rely:

Report Title	Date of Report	Technical Data
Geotechnical Engineering Study	Apr 11, 2023	Geotechnical information

- F. The following table lists the drawings of existing physical conditions at or adjacent to the Site, including those drawings depicting existing surface or subsurface structures at or adjacent to the Site (except Underground Facilities), that contain Technical Data, and specifically identifies the Technical Data upon which Contractor may rely:

Drawings Title	Date of Drawings	Technical Data
None.		

- G. Contractor may examine copies of reports and drawings identified in SC-5.03.E and SC-5.03.F that were not included with the Bidding Documents, by requesting such from the Engineer in writing.

5.06 *Hazardous Environmental Conditions*

SC-5.06 Add the following new paragraphs immediately after Paragraph 5.06.A.3:

4. The following table lists the reports known to Owner relating to Hazardous Environmental Conditions at or adjacent to the Site, and the Technical Data (if any) upon which Contractor may rely:

Report Title	Date of Report	Technical Data
None.		

5. The following table lists the drawings known to Owner relating to Hazardous Environmental Conditions at or adjacent to the Site, and Technical Data (if any) contained in such Drawings upon which Contractor may rely:

Drawings Title	Date of Drawings	Technical Data
None.		

ARTICLE 6—BONDS AND INSURANCE

6.01 *Performance, Payment, and Other Bonds*

SC-6.01 Add the following paragraphs immediately after Paragraph 6.01.A:

1. *Required Performance Bond Form:* The performance bond that Contractor furnishes will be in the form of EJCDC® C-610, Performance Bond (2010, 2013, or 2018 edition).
2. *Required Payment Bond Form:* The payment bond that Contractor furnishes will be in the form of EJCDC® C-615, Payment Bond (2010, 2013, or 2018 edition).

6.02 *Insurance—General Provisions*

SC-6.02 Add the following paragraph immediately after Paragraph 6.02.B:

1. Contractor may obtain worker’s compensation insurance from an insurance company that has not been rated by A.M. Best, provided that such company (a) is domiciled in the state in which the Project is located, (b) is certified or authorized as a worker’s compensation insurance provider by the appropriate state agency, and (c) has been accepted to provide worker’s compensation insurance for similar projects by the state within the last 12 months.

6.03 *Contractor’s Insurance*

SC-6.03 Supplement Paragraph 6.03 with the following provisions after Paragraph 6.03.C:

- D. *Other Additional Insureds:* As a supplement to the provisions of Paragraph 6.03.C of the General Conditions, the commercial general liability, automobile liability, umbrella or excess, pollution liability, and unmanned aerial vehicle liability policies must include as additional insureds (in addition to Owner and Engineer) the following:

OWNER: City of Pikeville

ENGINEER: Hussey Gay Bell & DeYoung, Inc.

- E. *Workers’ Compensation and Employer’s Liability:* Contractor shall purchase and maintain workers’ compensation and employer’s liability insurance, including, as applicable, United States Longshoreman and Harbor Workers’ Compensation Act, Jones Act, stop-gap employer’s liability coverage for monopolistic states, and foreign voluntary workers’ compensation (from available sources, notwithstanding the jurisdictional requirement of Paragraph 6.02.B of the General Conditions).

Workers' Compensation and Related Policies	Policy limits of not less than:
Workers' Compensation	
State	Statutory
Applicable Federal (e.g., Longshoreman's)	Statutory
Foreign voluntary workers' compensation (employer's responsibility coverage), if applicable	Statutory
Jones Act (if applicable)	
Bodily injury by accident—each accident	\$1,000,000
Bodily injury by disease—aggregate	\$1,000,000
Employer's Liability	
Each accident	\$1,000,000
Each employee	\$1,000,000
Policy limit	\$1,000,000
Stop-gap Liability Coverage	
For work performed in monopolistic states, stop-gap liability coverage must be endorsed to either the worker's compensation or commercial general liability policy with a minimum limit of:	\$1,000,000

- F. *Commercial General Liability—Claims Covered:* Contractor shall purchase and maintain commercial general liability insurance, covering all operations by or on behalf of Contractor, on an occurrence basis, against claims for:
1. damages because of bodily injury, sickness or disease, or death of any person other than Contractor's employees,
 2. damages insured by reasonably available personal injury liability coverage, and
 3. damages because of injury to or destruction of tangible property wherever located, including loss of use resulting therefrom.
- G. *Commercial General Liability—Form and Content:* Contractor's commercial liability policy must be written on a 1996 (or later) Insurance Services Organization, Inc. (ISO) commercial general liability form (occurrence form) and include the following coverages and endorsements:
1. Products and completed operations coverage.
 - a. Such insurance must be maintained for three years after final payment.
 - b. Contractor shall furnish Owner and each other additional insured (as identified in the Supplementary Conditions or elsewhere in the Contract) evidence of continuation of such insurance at final payment and three years thereafter.
 2. Blanket contractual liability coverage, including but not limited to coverage of Contractor's contractual indemnity obligations in Paragraph 7.18.
 3. Severability of interests and no insured-versus-insured or cross-liability exclusions.
 4. Underground, explosion, and collapse coverage.
 5. Personal injury coverage.

6. Additional insured endorsements that include both ongoing operations and products and completed operations coverage through ISO Endorsements CG 20 10 10 01 and CG 20 37 10 01 (together). If Contractor demonstrates to Owner that the specified ISO endorsements are not commercially available, then Contractor may satisfy this requirement by providing equivalent endorsements.
 7. For design professional additional insureds, ISO Endorsement CG 20 32 07 04 “Additional Insured—Engineers, Architects or Surveyors Not Engaged by the Named Insured” or its equivalent.
- H. *Commercial General Liability—Excluded Content:* The commercial general liability insurance policy, including its coverages, endorsements, and incorporated provisions, must not include any of the following:
1. Any modification of the standard definition of “insured contract” (except to delete the railroad protective liability exclusion if Contractor is required to indemnify a railroad or others with respect to Work within 50 feet of railroad property).
 2. Any exclusion for water intrusion or water damage.
 3. Any provisions resulting in the erosion of insurance limits by defense costs other than those already incorporated in ISO form CG 00 01.
 4. Any exclusion of coverage relating to earth subsidence or movement.
 5. Any exclusion for the insured’s vicarious liability, strict liability, or statutory liability (other than worker’s compensation).
 6. Any limitation or exclusion based on the nature of Contractor’s work.
 7. Any professional liability exclusion broader in effect than the most recent edition of ISO form CG 22 79.
- I. *Commercial General Liability—Minimum Policy Limits*

Commercial General Liability	Policy limits of not less than:
General Aggregate	\$1,000,000
Products—Completed Operations Aggregate	\$1,000,000
Personal and Advertising Injury	\$1,000,000
Bodily Injury and Property Damage—Each Occurrence	\$1,000,000

- J. *Automobile Liability:* Contractor shall purchase and maintain automobile liability insurance for damages because of bodily injury or death of any person or property damage arising out of the ownership, maintenance, or use of any motor vehicle. The automobile liability policy must be written on an occurrence basis.

Automobile Liability	Policy limits of not less than:
Bodily Injury	
Each Person	\$1,000,000
Each Accident	\$1,000,000

Automobile Liability	Policy limits of not less than:
Property Damage	
Each Accident	\$1,000,000
[or]	
Combined Single Limit	
Combined Single Limit (Bodily Injury and Property Damage)	\$1,000,000

6.04 *Builder's Risk and Other Property Insurance*

SC-6.04 Delete Paragraph 6.04.A and insert the following in its place:

A. Builder's Risk insurance is not required by the Contractor.

SC-6.04 Supplement Paragraph 6.04 of the General Conditions with the following provisions:

F. *Builder's Risk Requirements:* The builder's risk insurance must:

1. be written on a builder's risk "all risk" policy form that at a minimum includes insurance for physical loss or damage to the Work, temporary buildings, falsework, and materials and equipment stored and in transit, and must not exclude the coverage of the following risks: fire; windstorm; hail; flood; earthquake, volcanic activity, and other earth movement; lightning; riot; civil commotion; terrorism; vehicle impact; aircraft; smoke; theft; vandalism and malicious mischief; mechanical breakdown, boiler explosion, and artificially generated electric current; collapse; explosion; debris removal; demolition occasioned by enforcement of Laws and Regulations; and water damage (other than that caused by flood).
 - a. Such policy will include an exception that results in coverage for ensuing losses from physical damage or loss with respect to any defective workmanship, methods, design, or materials exclusions.
 - b. If insurance against mechanical breakdown, boiler explosion, and artificially generated electric current; earthquake, volcanic activity, and other earth movement; or flood, are not commercially available under builder's risk policies, by endorsement or otherwise, such insurance will be provided through other insurance policies acceptable to Owner and Contractor.
2. cover, as insured property, at least the following: (a) the Work and all materials, supplies, machinery, apparatus, equipment, fixtures, and other property of a similar nature that are to be incorporated into or used in the preparation, fabrication, construction, erection, or completion of the Work, including Owner-furnished or assigned property; (b) spare parts inventory required within the scope of the Contract; and (c) temporary works which are not intended to form part of the permanent constructed Work but which are intended to provide working access to the Site, or to the Work under construction, or which are intended to provide temporary support for the Work under construction, including scaffolding, form work, fences, shoring, falsework, and temporary structures.
3. cover expenses incurred in the repair or replacement of any insured property (including but not limited to fees and charges of contractors, engineers, and architects).

4. extend to cover damage or loss to insured property while in temporary storage at the Site or in a storage location outside the Site (but not including property stored at the premises of a manufacturer or Supplier). If this coverage is subject to a sublimit, such sublimit will be a minimum of \$1,000,000.00.
5. extend to cover damage or loss to insured property while in transit. If this coverage is subject to a sublimit, such sublimit will be a minimum of \$1,000,000.00.
6. allow for the waiver of the insurer's subrogation rights, as set forth in this Contract.
7. allow for partial occupancy or use by Owner by endorsement, and without cancellation or lapse of coverage.
8. include performance/hot testing and start-up, if applicable.
9. be maintained in effect until the Work is complete, as set forth in Paragraph 15.06.D of the General Conditions, or until written confirmation of Owner's procurement of property insurance following Substantial Completion, whichever occurs first.
10. include as named insureds the Owner, Contractor, Subcontractors (of every tier), and any other individuals or entities required by this Contract to be insured under such builder's risk policy. For purposes of Paragraphs 6.04, 6.05, and 6.06 of the General Conditions, and this and all other corresponding Supplementary Conditions, the parties required to be insured will be referred to collectively as "insureds." In addition to Owner, Contractor, and Subcontractors of every tier, include as insureds the following:
 - a. As necessary.
11. include, in addition to the Contract Price amount, the value of the following equipment and materials to be installed by the Contractor but furnished by the Owner or third parties:
 - a. None.
12. If debris removal in connection with repair or replacement of insured property is subject to a coverage sublimit, such sublimit will be a minimum of \$1,000,000.00.
13. In addition to the coverage sublimits stated above, the following coverages are also subject to sublimits, as follows:
 - a. None.

SC-6.04 Supplement Paragraph 6.04 of the General Conditions with the following provision:

- G. *Coverage for Completion Delays:* The builder's risk policy will include, for the benefit of Owner, loss of revenue and soft cost coverage for losses arising from delays in completion that result from covered physical losses or damage. Such coverage will include, without limitation, fixed expenses and debt service for a minimum of 12 months with a maximum deductible of 30 days, compensation for loss of net revenues, rental costs, and attorneys' fees and engineering or other consultants' fees, if not otherwise covered.

SC-6.04 Supplement Paragraph 6.04 of the General Conditions with the following provisions:

- H. *Builder's Risk and Other Property Insurance Deductibles:* The purchaser of any required builder's risk, installation floater, or other property insurance will be responsible for costs not covered because of the application of a policy deductible.

ARTICLE 7—CONTRACTOR’S RESPONSIBILITIES

7.03 *Labor; Working Hours*

SC-7.03 Add the following new subparagraphs immediately after Paragraph 7.03.C:

- 1. Regular working hours will be 7:00 A.M. to 5:00 P.M. weekdays.
- 2. Owner's legal holidays are:

New Year’s Day	Veteran’s Day
Dr. Martin Luther King Jr. Day	Thanksgiving Day
Memorial Day	Day After Thanksgiving
Independence Day	Christmas Day
Labor Day	

SC-7.03 Add the following new paragraph immediately after Paragraph 7.03.C:

- D. Contractor shall be responsible for the cost of any overtime pay or other expense incurred by the Owner for Engineer’s services (including those of the Resident Project Representative, if any), Owner's representative, and construction observation services, occasioned by the performance of Work on Saturday, Sunday, any legal holiday, or as overtime on any regular work day. If Contractor is responsible but does not pay, or if the parties are unable to agree as to the amount owed, then Owner may impose a reasonable set-off against payments due under Article 15.

SC-7.03 Add the following new subparagraph immediately after Paragraph SC-7.03.D:

- 1. For purposes of administering the foregoing requirement, additional overtime costs are defined as determined by the Owner.

7.13 *Safety and Protection*

SC-7.13 Insert the following after the second sentence of Paragraph 7.13.G:

The following Owner safety programs are applicable to the Work:

ARTICLE 8—OTHER WORK AT THE SITE

8.02 **OMITTED**

ARTICLE 9—OWNER’S RESPONSIBILITIES

9.13 **OMITTED**

ARTICLE 10—ENGINEER’S STATUS DURING CONSTRUCTION

10.03 *Resident Project Representative*

SC-10.03 Add the following new subparagraph immediately after Paragraph 10.03.A:

1. On this Project, by agreement with the Owner, the Engineer will not furnish a Resident Project Representative to represent Engineer at the Site or assist Engineer in observing the progress and quality of the Work.

ARTICLE 11—CHANGES TO THE CONTRACT

No suggested Supplementary Conditions in this Article.

ARTICLE 12—CLAIMS

No suggested Supplementary Conditions in this Article.

ARTICLE 13—COST OF WORK; ALLOWANCES, UNIT PRICE WORK

13.03 Unit Price Work

SC-13.03 Delete Paragraph 13.03.E in its entirety and insert the following in its place:

E. Adjustments in Unit Price

1. Contractor or Owner shall be entitled to an adjustment in the unit price with respect to an item of Unit Price Work if:
 - a. the extended price of a particular item of Unit Price Work amounts to 25% percent or more of the Contract Price (based on estimated quantities at the time of Contract formation) and the variation in the quantity of that particular item of Unit Price Work actually furnished or performed by Contractor differs by more than 25% percent from the estimated quantity of such item indicated in the Agreement; and
 - b. Contractor's unit costs to perform the item of Unit Price Work have changed materially and significantly as a result of the quantity change.
2. The adjustment in unit price will account for and be coordinated with any related changes in quantities of other items of Work, and in Contractor's costs to perform such other Work, such that the resulting overall change in Contract Price is equitable to Owner and Contractor.
3. Adjusted unit prices will apply to all units of that item.

ARTICLE 14—TESTS AND INSPECTIONS; CORRECTION, REMOVAL, OR ACCEPTANCE OF DEFECTIVE WORK

No suggested Supplementary Conditions in this Article.

ARTICLE 15—PAYMENTS TO CONTRACTOR, SET OFFS; COMPLETIONS; CORRECTION PERIOD

15.01 Progress Payments

SC-15.03 Add the following new subparagraph to Paragraph 15.03.B:

1. If some or all of the Work has been determined not to be at a point of Substantial Completion and will require re-inspection or re-testing by Engineer, the cost of such re-inspection or re-testing, including the cost of time, travel and living expenses, will be paid by Contractor to Owner. If Contractor does not pay, or the parties are unable to agree as to the amount owed, then Owner may impose a reasonable set-off against payments due under this Article 15.

15.08 *Correction Period*

SC-15.08 Add the following new Paragraph 15.08.G:

- G. The correction period specified as one year after the date of Substantial Completion in Paragraph 15.08.A of the General Conditions is hereby revised to be the number of years set forth in SC-6.01.B.1; or if no such revision has been made in SC-6.01.B, then the correction period is hereby specified to be **[number]** years after Substantial Completion.

ARTICLE 16—SUSPENSION OF WORK AND TERMINATION

No suggested Supplementary Conditions in this Article.

ARTICLE 17—FINAL RESOLUTIONS OF DISPUTES

17.02 *Arbitration*

SC-17.02 Add the following new paragraph immediately after Paragraph 17.01.

17.02 *Arbitration*

- A. All matters subject to final resolution under this Article will be settled by arbitration administered by the American Arbitration Association in accordance with its Construction Industry Arbitration Rules (subject to the conditions and limitations of this Paragraph SC-17.02). Any controversy or claim in the amount of \$100,000 or less will be settled in accordance with the American Arbitration Association's supplemental rules for Fixed Time and Cost Construction Arbitration. This agreement to arbitrate will be specifically enforceable under the prevailing law of any court having jurisdiction.
- B. The demand for arbitration will be filed in writing with the other party to the Contract and with the selected arbitration administrator, and a copy will be sent to Engineer for information. The demand for arbitration will be made within the specific time required in Article 17, or if no specified time is applicable within a reasonable time after the matter in question has arisen, and in no event will any such demand be made after the date when institution of legal or equitable proceedings based on such matter in question would be barred by the applicable statute of limitations.
- C. The arbitrator(s) must be licensed engineers, contractors, attorneys, or construction managers. Hearings will take place pursuant to the standard procedures of the Construction Arbitration Rules that contemplate in-person hearings. The arbitrators will have no authority to award punitive or other damages not measured by the prevailing party's actual damages, except as may be required by statute or the Contract. Any award in an arbitration initiated

under this clause will be limited to monetary damages and include no injunction or direction to any party other than the direction to pay a monetary amount.

- D. The Arbitrators will have the authority to allocate the costs of the arbitration process among the parties, but will only have the authority to allocate attorneys' fees if a specific Law or Regulation or this Contract permits them to do so.
- E. The award of the arbitrators must be accompanied by a reasoned written opinion and a concise breakdown of the award. The written opinion will cite the Contract provisions deemed applicable and relied on in making the award.
- F. The parties agree that failure or refusal of a party to pay its required share of the deposits for arbitrator compensation or administrative charges will constitute a waiver by that party to present evidence or cross-examine witness. In such event, the other party shall be required to present evidence and legal argument as the arbitrator(s) may require for the making of an award. Such waiver will not allow for a default judgment against the non-paying party in the absence of evidence presented as provided for above.
- G. No arbitration arising out of or relating to the Contract will include by consolidation, joinder, or in any other manner any other individual or entity (including Engineer, and Engineer's consultants and the officers, directors, partners, agents, employees or consultants of any of them) who is not a party to this Contract unless:
 - 1. the inclusion of such other individual or entity will allow complete relief to be afforded among those who are already parties to the arbitration;
 - 2. such other individual or entity is substantially involved in a question of law or fact which is common to those who are already parties to the arbitration, and which will arise in such proceedings;
 - 3. such other individual or entity is subject to arbitration under a contract with either Owner or Contractor, or consents to being joined in the arbitration; and
 - 4. the consolidation or joinder is in compliance with the arbitration administrator's procedural rules.
- H. The award will be final. Judgment may be entered upon it in any court having jurisdiction thereof, and it will not be subject to modification or appeal, subject to provisions of the Laws and Regulations relating to vacating or modifying an arbitral award.
- I. Except as may be required by Laws or Regulations, neither party nor an arbitrator may disclose the existence, content, or results of any arbitration hereunder without the prior written consent of both parties, with the exception of any disclosure required by Laws and Regulations or the Contract. To the extent any disclosure is allowed pursuant to the exception, the disclosure must be strictly and narrowly limited to maintain confidentiality to the extent possible.

ARTICLE 18—MISCELLANEOUS

18.01 EXISTING CONDITIONS AND PROPERTY

The Contractor shall restore and replace any public or private property damaged or removed during the construction of this project.

EXHIBIT A—SOFTWARE REQUIREMENTS FOR ELECTRONIC DOCUMENT EXCHANGE

Item	Electronic Documents	Transmittal Means	Data Format	Note (1)
a.1	General communications, transmittal covers, meeting notices and responses to general information requests for which there is no specific prescribed form.	Email	Email	
a.2	Meeting agendas, meeting minutes, RFI's and responses to RFI's, and Contract forms.	Email w/ Attachment	PDF	(2)
a.3	Contractors Submittals (Shop Drawings, "or equal" requests, substitution requests, documentation accompanying Sample submittals and other submittals) to Owner and Engineer, and Owner's and Engineer's responses to Contractor's Submittals, Shop Drawings, correspondence, and Applications for Payment.	Email w/ Attachment	PDF	
a.4	Correspondence; milestone and final version Submittals of reports, layouts, Drawings, maps, calculations and spreadsheets, Specifications, Drawings and other Submittals from Contractor to Owner or Engineer and for responses from Engineer and Owner to Contractor regarding Submittals.	Email w/ Attachment or LFE	PDF	
a.5	Layouts and drawings to be submitted to Owner for future use and modification.	Email w/ Attachment or LFE	DWG	
a.6	Correspondence, reports and Specifications to be submitted to Owner for future word processing use and modification.	Email w/ Attachment or LFE	DOC	
a.7	Spreadsheets and data to be submitted to Owner for future data processing use and modification.	Email w/ Attachment or LFE	EXC	
a.8	Database files and data to be submitted to Owner for future data processing use and modification.	Email w/ Attachment or LFE	DB	
Notes				
(1)	All exchanges and uses of transmitted data are subject to the appropriate provisions of Contract Documents.			
(2)	Transmittal of written notices is governed by Paragraph 18.01 of the General Conditions.			
Key				
Email	Standard Email formats (.htm, .rtf, or .txt). Do not use stationery formatting or other features that impair legibility of content on screen or in printed copies			
LFE	Agreed upon Large File Exchange method (FTP, CD, DVD, hard drive)			
PDF	Portable Document Format readable by Adobe® Acrobat Reader Version			
DWG	Autodesk® AutoCAD .dwg format			
DOC	Microsoft® Word .docx format			

EXC	Microsoft® Excel .xls or .xml format
DB	Microsoft® Access .mdb format

EXHIBIT B—FORESEEABLE BAD WEATHER DAYS

Month	Number of Foreseeable Bad Weather Days in Month Based on Precipitation as Rain Equivalent (inches) (1)	Ambient Outdoor Air Temperature (degrees F)	
		Number of Foreseeable Bad Weather Days in Month Based on Low Temperature (at 11:00 a.m.)	Number of Foreseeable Bad Weather Days in Month Based on High Temperature (at 3:00 p.m.)
January	4	0	0
February	6	0	0
March	6	0	0
April	4	0	0
May	4	0	0
June	2	0	0
July	2	0	0
August	4	0	0
September	4	0	0
October	4	0	0
November	4	0	0
December	4	0	0

Notes:

- Two inches of sleet equal one inch of rain. Five inches of wet, heavy snow equal one inch of rain. Fifteen inches of “dry” powder snow equals one inch of rain.

This document has important legal consequences; consultation with an attorney is encouraged with respect to its use or modification. This document should be adapted to the particular circumstances of the contemplated Project and the controlling Laws and Regulations.

WORK CHANGE DIRECTIVE

Prepared By



Endorsed By



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WORK CHANGE DIRECTIVE NO.: _____

Owner: City of Pikeville
Engineer: Hussey Gay Bell
Contractor:
Project: Pikeville 0.366 MGD Wastewater Treatment Plant
Contract Name: Pikeville 0.366 MGD Wastewater Treatment Plant
Date Issued: __/__/__

Owner's Project No.:
Engineer's Project No.: 120300101
Contractor's Project No.:

Effective Date of Work Change Directive: __/__/__

Contractor is directed to proceed promptly with the following change(s):

Description:

Attachments:

Purpose for the Work Change Directive:

Directive to proceed promptly with the Work described herein, prior to agreeing to change in Contract Price and Contract Time, is issued due to:

Non-agreement on pricing of proposed change. Necessity to proceed for schedule or other reasons.

Estimated Change in Contract Price and Contract Times (non-binding, preliminary):

Contract Price: \$ _____ [increase] [decrease].

Contract Time: _____ days [increase] [decrease].

Basis of estimated change in Contract Price:

Lump Sum Unit Price Cost of the Work Other

Recommended by Engineer

Authorized by Owner

By: _____

Title: _____

Date: _____

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CHANGE ORDER

Prepared By



Endorsed By



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CHANGE ORDER NO.: _____

Owner: City of Pikeville
 Engineer: Hussey Gay Bell
 Contractor:
 Project: Pikeville 0.366 MGD Wastewater Treatment Plant
 Contract Name: Pikeville 0.366 MGD Wastewater Treatment Plant
 Date Issued: ___ / ___ / ___

Owner's Project No.:
 Engineer's Project No.: 120300101
 Contractor's Project No.:

Effective Date of Change Order: ___ / ___ / ___

The Contract is modified as follows upon execution of this Change Order:

Description:

Attachments:

Change in Contract Price	Change in Contract Times (___ Days)
Original Contract Price: \$ _____	Original Contract Times: Substantial Completion: _____ Ready for final payment: _____
[Increase] [Decrease] from previously approved Change Orders No. 1 to No. [Number of previous Change Order] : \$ _____	[Increase] [Decrease] from previously approved Change Orders No.1 to No. [Number of previous Change Order] : Substantial Completion: _____ Ready for final payment: _____
Contract Price prior to this Change Order: \$ _____	Contract Times prior to this Change Order: Substantial Completion: _____ Ready for final payment: _____
[Increase] [Decrease] this Change Order: \$ _____	[Increase] [Decrease] this Change Order: Substantial Completion: _____ Ready for final payment: _____
Contract Price incorporating this Change Order: \$ _____	Contract Times with all approved Change Orders: Substantial Completion: _____ Ready for final payment: _____

Recommended by Engineer (if required)

Accepted by Contractor

By: _____
 Title: _____
 Date: _____

Authorized by Owner

Approved by Funding Agency (if applicable)

By: _____
 Title: _____
 Date: _____

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FIELD ORDER

Prepared By



Endorsed By



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FIELD ORDER NO.: _____

Owner: City of Pikeville
Engineer: Hussey Gay Bell
Contractor:
Project: Pikeville 0.366 MGD Wastewater Treatment Plant
Contract Name: Pikeville 0.366 MGD Wastewater
Treatment Plant
Date Issued: __/__/__

Owner's Project No.:
Engineer's Project No.: 120300101
Contractor's Project No.:

Date of Field Order: __/__/__

Contractor is hereby directed to promptly perform the Work described in this Field Order, issued in accordance with Paragraph 11.04 of the General Conditions, for minor changes in the Work without changes in Contract Price or Contract Times. If Contractor considers that a change in Contract Price or Contract Times is required, submit a Change Proposal before proceeding with this Work.

Reference:

Description:

Attachments:

Issued by Engineer

By: _____

Title: _____

Date: _____

SECTION 011500
MEASUREMENT AND PAYMENT

PART 1 - MEASUREMENT

- 1.01 The items listed in the proposal shall be considered as sufficient to complete the work in accordance with the plans and specifications. Any portion of the work not listed in the bid form shall be deemed to be a part of the item which it is associated with and shall be included in the cost of the unit shown on the bid form. Payment for the unit shown on the bid form shall be considered to cover the cost of all labor, material, equipment and performing all operations necessary to complete the work in place. The unit of measurement shall be the unit shown on the bid form. Payment shall be based upon the actual quantity multiplied by the unit prices. Where work is to be performed at a lump sum price, the lump sum shall include all operations and elements necessary to complete the work. No payment will be made for any material wasted, unused, rejected, or used for the convenience of the Contractor.

ESTIMATED QUANTITIES:

- 1.02 All estimated quantities for unit price items, stipulated in the Bid Form, or other Contract Documents, are approximate and are to be used as a basis for estimating the probable cost of the work and for comparing the bids submitted for the Project. The actual amounts of work done and materials furnished under price items may differ from the estimated quantities. The basis of payment for work and materials will be the actual amount of work done and material furnished. The Contractor agrees to make no claim for damages, anticipated profits or otherwise on account of any difference between the amounts of work actually performed and materials actually furnished and the estimated amounts included in the Bid Form.

LUMP SUM AND UNIT PRICE QUANTITIES:

- 1.03 All quantities are for unit price or lump sum items stipulated in the Bid Form. The Contractor, having read and understood the Bidding Documents and examined the Project sites and adjoining areas, and being familiar with the obstacles and conditions that will affect proposed work, hereby offers and agrees to furnish all labor, products, and services needed to provide work in accordance with the Bidding Documents and will provide a properly itemized listing for each bid item, supported by sufficiently substantially data, to permit evaluation of partial pay requests.

PART 2 - PAYMENT – PIKEVILLE 0.366 MGD WASTEWATER TREATMENT PLANT

2.01 LUMP SUM PAYMENT (Refer to Bid Item 1)

Payment shall be on the basis of the lump sum bid which shall include all work and shall include but is not limited to the following:

- A. Clearing, grading and all general site work including all rock excavation.
- B. Influent Screens & Structures
- C. Carrousel Aeration Basin & System
- D. Splitter Boxes
- E. Chemical Disinfection System and Structures
- F. Drain Pump Station
- G. WAS/RAS Pump Station
- H. Post Aeration System and Parshall Flumes
- I. Belt Filter Press and Building
- J. Aerobic Digester & Associated Equipment
- K. Control/Lab Building
- L. Electrical System & Secondary Electrical Building
- M. Instrumentation (exclusive of MR Systems Allowance)
- N. Utility piping, grading, drainage, grassing and all other work shown on the Plans, specified herein or necessary to make a complete and operable system.
- O. Incidental and/or indirect costs associated with Health and Safety Regulations, flagmen, barricades, temporary construction, permits and similar items.

2.02 LAB EQUIPMENT ALLOWANCE (Refer to Bid Item 2)

Payment shall be made for the purchase of all necessary lab equipment and the work necessary to furnish the lab equipment. The owner shall choose all necessary equipment to be purchased.

Payment shall include furnishing and installation of all lab equipment, hardware, software, and accessories necessary to ensure a completely operational lab. Payment shall be made based on the lump sum allowance provided in the bid form plus 7% sales tax.

2.03 ALLOWANCE FOR WWTP PLAQUE (Refer to Bid Item 3)

Payment shall be made for the purchase of a plaque for the WWTP. The plaque design shall be approved by the City of Pikeville before purchasing.

Payment shall include furnishing and installation of the plaque and all associated equipment. Payment shall be made based on the lump sum allowance provided in the bid form plus 7% sales tax.

2.04 MR SYSTEM ALLOWANCE (Refer to Bid Item 4)

Payment shall be made for the purchase of SCADA equipment and work described in the MR Systems scope of supply and specifications in the Appendix of the specifications.

Payment shall include furnishing and installation of all equipment, hardware, software, and accessories necessary to make the MR system completely operational. Payment shall be made based on the lump sum allowance provided in the MR proposal plus 7% sales tax.

2.05 CREDIT FOR ALTERNATE AERATION/CLARIFIER DESIGN (Bid Item 1A.)

A credit shall be provided if the contractor proceeds with an alternate supplier for the aeration basin and the clarifiers. This credit shall include the alternate aeration basin and clarifier re-design of the structures and installation of the associated equipment.

PART 3 – SUMMARY OF ITEM TOTALS:

The Bidder shall fill in the appropriate totals which shall be used as the basis for comparison of bids. The Owner reserves the right to award the Contract in the best interest of the Owner. The total Contract amounts will be determined upon completion of the project using the quantities actually incorporated into the project corresponding to the unit prices and lump sum amounts in the Bid Proposal.

Payment shall be considered to cover the cost of all labor, supervision, material, equipment and performing all operations necessary to complete the work in place. The items listed in the proposal shall be considered as sufficient to complete the work in accordance with the Drawings and Specifications; incidental items of work not listed in the bid form shall be a part of the item with which it is associated and shall be included in the cost of the unit shown on the bid form. The unit of measurement shall be the unit shown in the proposal. Payment will be based upon the actual quantity multiplied by the unit price.

END OF SECTION

SECTION 03 20 00

CONCRETE REINFORCEMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section specifies concrete reinforcing, including all materials, labor, equipment, and services necessary to complete work.

1.2 SUBMITTALS

- A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections including the number of sets. Sets in excess of the number indicated in the General Conditions will be discarded. One set will be retained by the structural department and the remaining sets will be returned to the Architect.
 - 1. All submittals should be produced in a digital PDF format. Submittals will be checked and any comments will be added to the digital PDF file. The PDF file, with any comments, will be returned to the contractor.
 - 2. The contractor is responsible to check all submittals for accuracy and coordination with other trade. This check is required to be performed by the contractor prior to making any submittals to the architect or engineer any submittals that do not have clear proof that the contractor performed this required choice will be returned without review.
- B. Product data for proprietary materials and items, including reinforcement and others if requested by Architect.
- C. Shop drawings for reinforcement detailing fabricating, bending and placing concrete reinforcement. Comply with ACI 315 "Manual of Standard Practice for Detailing Reinforced Concrete Structures" showing bar schedules, stirrup spacing, bent bar diagrams, and arrangement of concrete reinforcement. Include special reinforcing required for openings through concrete structures. In addition, submit data on reinforcing support types to be used.
- D. Material certificates in lieu of material laboratory test reports when permitted by Architect. Material certificates shall be signed by manufacturer and Contractor, certifying that each material item complies with or exceeds specified requirements.

Provide certification from admixture manufacturers that chloride content complies with specification requirements.

1.3 QUALITY ASSURANCE

- A. Codes and Standards: Comply with provisions of the following codes, specifications, and standards, except where more stringent requirements are shown or specified:
 - 1. American Concrete Institute (ACI) 301, "Specifications for Structural Concrete for Buildings."
 - 2. ACI 318, "Building Code Requirements for Reinforced Concrete."
 - 3. Concrete Reinforcing Steel Institute (CRSI) "Manual of Standard Practice."
- B. Materials and installed work may require testing and retesting at any time during the progress of Work. Tests, including retesting of rejected materials for installed Work, shall be done at Contractor's expense.

PART 2 - PRODUCTS

2.1 REINFORCING MATERIALS

- A. Reinforcing Bars: ASTM A 615 Grade 60, deformed.
- B. Steel Wire: ASTM A185, plain, cold-drawn steel.
- C. Supports for Reinforcement: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire fabric in place. Use wire bar-type supports complying with CRSI specifications.
 - 1. For slabs-on-grade, use supports with sand plates or horizontal runners where base material will not support chair legs.
 - 2. For exposed-to-view concrete surfaces where legs of supports are in contact with forms, provide supports with legs that are protected by plastic (CRSI, Class 1) or stainless steel (CRSI, Class 2).
 - 3. Tie wire shall not be less than 16 gauge black annealed wire.

PART 3 - EXECUTION

3.1 GENERAL

- A. Coordinate the installation of joint materials, vapor retarder/barrier, and other

related materials with the placement of forms and reinforcing steel.

3.2 PLACING REINFORCEMENT

- A. General: Comply with Concrete Reinforcing Steel Institute's recommended practice for "Placing Reinforcing Bars," for details and methods of reinforcement placement and supports and as specified.
 - 1. Avoiding cutting or puncturing vapor retarder/barrier during reinforcement placement and concreting operations. Repair damages before placing concrete.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, and other materials that reduce or destroy bond with the concrete.
- C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcing by metal chairs, runners, bolsters, spacers, and hangers, as approved by Architect. Support reinforcing within the following tolerances from the positions shown on the drawings or specified herein:
 - 1. For clear concrete protection and for depth "d" in Flexural members, walls, and compression members where "d" is:
 - a. 8 inches or less ---- plus or minus 1/4 inch;
 - b. More than 8 inches ---- plus or minus 1/2 inch; but the cover shall not be reduced by more than one-half of the specified cover.
 - 2. For longitudinal location of bends and ends of bars:
 - a. +/- 2 inches except at discontinuous ends of members where tolerance shall be +/- 1/2 Inch.
 - 3. For spacing:
 - a. +/- 2 inches except that the total number of bars shall not be reduced.
- D. Place reinforcement to maintain minimum coverages as required for concrete protection in accordance with ACI 318. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement operations. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces.
- E. Vertical Bars in piers shall be offset one bar diameter at lapped splices. Furnish templates for setting dowels.
- F. "Continuous" Bars, unless otherwise indicated on drawings, shall be lapped 50 diameters at splices. Provide Corner Bars at corner conditions.
- G. Splices not shown in contract documents shall be subject to approval.
- H. Support all Reinforcing Bars.

- I. Space Bar Supports a maximum of 4-feet on center with the first support not greater than 1-foot from the ends of the bars. Tie to prevent displacement during the concreting operations. Provide #4 support bars at 48-inches spacing where not supported otherwise.
- J. Reinforcement shall not be “field” bent after being embedded in hardened concrete except where specifically shown on the Drawings.

3.3 PLACEMENT/WELDED WIRE FABRIC

- A. Welded Wire Fabric shall be placed in specified positions in the forms and held in place, before and during the placing of concrete, by means of Support Bars or wire chairs and ties.
- B. Bar supports shall be for Reinforcing Bars. Install welded wire fabric flat sheets. Do not use rolled wire. Lap adjoining pieces at least 12 inches and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.
- C. Welded Wire Fabric shall not be “pulled-up” into position during concrete placing operations.

END OF SECTION

SECTION 03 30 00

CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section specifies cast-in place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes, for the following:
 - 1. Foundations including wall footings, spread footings and footings monolithic with slab.
 - 2. Foundation walls.
 - 3. Tank walls and walkways.
 - 4. Slabs-on-grade.
 - 5. Concrete toppings.
 - 6. Load bearing walls.
 - 7. Starter walls.
 - 8. Equipment pads and bases.
- B. Related Sections include the following:
 - 1. Division 2 Section "Earthwork".

1.3 DEFINITIONS

- A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash and other pozzolans, ground granulated blast-furnace slag, and silica fume; subject to compliance with requirements.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1. Indicate amounts of mixing water to be withheld for later addition at Project site.
- C. Steel Reinforcement Shop Drawings: Placing drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement.
- D. Welding certificates.
- E. Qualification Data: For Installer.
- F. Material Test Reports: For the following, from a qualified testing agency, indicating compliance with requirements:
 1. Aggregates. Include service record data indicating absence of deleterious expansion of concrete due to alkali aggregate reactivity.
- G. Material Certificates: For each of the following, signed by manufacturers:
 1. Cementitious materials.
 2. Admixtures.
 3. Form materials and form-release agents.
 4. Steel reinforcement and accessories.
 5. Fiber reinforcement.
 6. Waterstops.
 7. Curing compounds.
 8. Floor and slab treatments.
 9. Bonding agents.
 10. Adhesives.
 11. Vapor retarders.
 12. Semirigid joint filler.
 13. Joint-filler strips.
 14. Repair materials.
- H. Field quality-control test and inspection reports.
- I. Minutes of preinstallation conference.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
 1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."

- B. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated, as documented according to ASTM E 548.
1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-01 or an equivalent certification program.
 2. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician - Grade I. Testing Agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician - Grade II.
- C. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from one source, and obtain admixtures through one source from a single manufacturer.
- D. Welding: Qualify procedures and personnel according to AWS D1.4, "Structural Welding Code-Reinforcing Steel."
- E. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:
1. ACI 301, "Specification for Structural Concrete".
 2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."
 3. ACI 318, "Building Code Requirements for Reinforced Concrete".
 4. ACI 350, "Code Requirements for Environmental Engineering Concrete Structures"
 5. Concrete Reinforcing Steel Institute (CRSI) "Manual of Standard Practice".
- F. Supervision: All reinforced concrete construction shall be performed under the personal supervision of the contractor's superintendent. The superintendent shall keep a record of all concrete placed on the job. The record shall show in detail the area placed, the time and date of the placement and weather conditions which existed at the time of placement. Upon completion of the work, this record shall be turned over to the Engineer.
- G. Concrete Testing Service: Contractor shall engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.
- H. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."
1. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:

- a. Contractor's superintendent.
 - b. Independent testing agency responsible for concrete design mixtures.
 - c. Ready-mix concrete manufacturer.
 - d. Concrete subcontractor.
2. Review testing and inspecting agency procedures for field quality control, concrete finishes and finishing, cold- and hot-weather concreting procedures, curing procedures, construction contraction and isolation joints, and joint-filler strips, semirigid joint fillers, forms and form removal limitations, shoring procedures, vapor-retarder installation, anchor rod and anchorage device installation tolerances, steel reinforcement installation, floor and slab flatness and levelness measurement, concrete repair procedures, and concrete protection.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage.
- B. Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.
 2. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2.2 FORM-FACING MATERIALS

- A. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.
 1. Plywood, metal, or other approved panel materials.
 2. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:
 - a. High-density overlay, Class 1 or better.

- b. Medium-density overlay, Class 1 or better; mill-release agent treated and edge sealed.
 - c. Structural 1, B-B or better; mill oiled and edge sealed.
 - d. B-B (Concrete Form), Class 1 or better; mill oiled and edge sealed.
- B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.
- C. Forms for Cylindrical Columns, Pedestals, and Supports: Metal, glass-fiber-reinforced plastic, paper, or fiber tubes that will produce surfaces with gradual or abrupt irregularities not exceeding specified formwork surface class. Provide units with sufficient wall thickness to resist plastic concrete loads without detrimental deformation.
- D. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch, minimum.
- E. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.
 - 1. Formulate form-release agent with rust inhibitor for steel form-facing materials.
- F. Form Ties: Factory-fabricated, removable or snap-off metal or glass-fiber-reinforced plastic form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.
 - 1. Furnish units that will leave no corrodible metal closer than 1 inch to the plane of exposed concrete surface.
 - 2. Furnish ties that, when removed, will leave holes no larger than 1 inch in diameter in concrete surface.
 - 3. Furnish ties with integral water-barrier plates to walls of liquid containing structures or walls indicated to receive dampproofing or waterproofing.

2.3 STEEL REINFORCEMENT

- A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.
- B. Low-Alloy-Steel Reinforcing Bars: ASTM A 706/A 706M, deformed.
- C. Steel Bar Mats: ASTM A 184/A 184M, fabricated from ASTM A 615/A 615M, Grade 60, deformed bars, assembled with clips.
- D. Plain-Steel Wire: ASTM A 82.
- E. Deformed-Steel Wire: ASTM A 496.

- F. Plain-Steel Welded Wire Reinforcement: ASTM A 185, plain, fabricated from as-drawn steel wire into flat sheets.
- G. Deformed-Steel Welded Wire Reinforcement: ASTM A 497, flat sheet.

2.4 REINFORCEMENT ACCESSORIES

- A. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60, plain-steel bars, cut bars true to length with ends square and free of burrs.
- B. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:
 - 1. For concrete surfaces exposed to view where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire or CRSI Class 2 stainless-steel bar supports.
 - 2. For foundations, support reinforcing a maximum of 4'-0" on center.

2.5 CONCRETE MATERIALS

- A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:
 - 1. Portland Cement: ASTM C 150, Type I/II except foundations (wall footings, spread footings, etc.) shall be Type II. **Use Type V cement for Bar Screen.** Supplement with the following:
 - a. Fly Ash: ASTM C 618, Class F.
 - b. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.
- B. Silica Fume: ASTM C 1240, amorphous silica.
- C. Normal-Weight Aggregates: ASTM C 33, Class 3M coarse aggregate or better, graded. Provide aggregates from a single source .
 - 1. Maximum Coarse-Aggregate Size: 1 inch nominal.
 - 2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
- D. Water: ASTM C 94/C 94M and potable.

2.6 ADMIXTURES

- A. Air-Entraining Admixture: ASTM C 260.

- B. Crystalline Cementitious Admixture: Provide crystalline cementitious admixture in all walls of liquid retaining structures.
1. Apply to the concrete mix in strict accordance with the manufacturer's instructions.
 2. Apply at dosing rate of not less than 12 pounds per cubic yard or more than 16 pounds per cubic yard of concrete
 3. Available Products:
 - a. Xypex - Admix C-500
 - b. Kryton International, Inc. - Krystol Internal Membrane
 - c. BASF Corporation – Masterlife 300D
 - d. Approved equal.
- C. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.
1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
 2. Retarding Admixture: ASTM C 494/C 494M, Type B.
 3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
 4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
 5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
 6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.
- D. Set-Accelerating Corrosion-Inhibiting Admixture: Commercially formulated, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete and complying with ASTM C 494/C 494M, Type C.
1. Available Products:
 - a. Boral Material Technologies, Inc.; Boral BCN.
 - b. Euclid Chemical Company (The); Eucon CIA.
 - c. Grace Construction Products, W. R. Grace & Co.; DCI.
 - d. Master Builders, Inc.; Rheocrete CNI.
 - e. Sika Corporation; Sika CNI.
 - f. Approved equal.
- E. Non-Set-Accelerating Corrosion-Inhibiting Admixture: Commercially formulated, non-set-accelerating, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete.
1. Available Products:
 - a. Axim Concrete Technologies; Catexol 1000CI.
 - b. Boral Material Technologies, Inc.; Boral BCN2.
 - c. Cortec Corporation; MCI 2000.

- d. Grace Construction Products, W. R. Grace & Co.; DCI-S.
- e. Master Builders, Inc.; Rheocrete 222+.
- f. Sika Corporation; FerroGard-901.
- g. Approved equal.

2.7 WATERSTOPS

A. Hydrophilic rubber waterstops:

- 1. Provide pre-formed expanding hydrophilic rubber and hydrophilic paste adhesive and related accessories.
 - a. Adeka Ultra Seal by Asahi Denka Kogyo; or
 - b. Hydrotite and Leakmaster by Greenstreak Plastic Products Company, Inc; or
 - c. Approved equal.
- 2. Provide pre-formed rubber strip.
 - a. Adeka MC-2010M; or
 - b. Hydrotite CJ1020-2K by Greenstreak Plastic Products Company, Inc; or
 - c. Approved equal.
- 3. Provide paste type hydrophilic waterstop compound to be used in conjunction with the rubber strip in accordance with the manufacturer's instructions.
 - a. Provide Adeka MC-201; or
 - b. Hydrotite and Leakmaster LV-1 by Greenstreak Plastic Products Company, Inc; or
 - c. Approved equal.
- 4. Provide adhesive bonding agent for installation as recommended by the manufacturer.
- 5. Provide other materials as recommended by the manufacturer for a complete and proper installation.

B. Flexible PVC Waterstops: CE CRD-C 572, manufactured from virgin polyvinyl chloride with factory-installed metal eyelets, for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes.

- 1. Acceptable products Greenstreak Group, Inc. "Model 646 or 679" (depending on length) or approved equal. For expansion joint, Greenstreak Group, Inc. "Model 726" or approved equal
- 2. Profile: Ribbed with center bulb at Expansion Joints. Flat center and Ribbed without center bulb for all other joints.
- 3. Dimensions: 6 inches by 3/8 inch thick, 9 inches by 3/8 inch thick, 12 inches by 3/8" thick, nontapered.

2.8 FIBER REINFORCEMENT

A. Synthetic Fiber: Macro synthetic fibers engineered and designed for use in concrete pavement, complying with ASTM C 1116, Type III, 1-1/2 inches long minimum

1. Available Products:

a. Fibers:

- 1) Axim Concrete Technologies; Maxima
- 2) Euclid Chemical Company (The); Tuf-Strand SF
- 3) FORTA Corporation; Forta-Ferro
- 4) Grace Construction Products, W. R. Grace & Co.; Strux 90/40
- 5) SI Concrete Systems; Fibermesh.650

2.9 VAPOR RETARDERS

A. Plastic Vapor Retarder: ASTM E 1745, Class A. Include manufacturer's recommended adhesive or pressure-sensitive tape.

1. Available Products:

- a. Fortifiber Corporation; Moistop Ultra A.
- b. Raven Industries Inc.; Vapor Block 10.
- c. Reef Industries, Inc.; Griffolyn Type-65G 105.
- d. Approved equal.

B. Plastic Vapor Retarder: ASTM E 1745, Class B. Include manufacturer's recommended adhesive or pressure-sensitive tape.

1. Available Products:

- a. Fortifiber Corporation; Moistop Ultra.
- b. Raven Industries Inc.; Vapor Block 10.
- c. Stego Industries, LLC; Stego Wrap, 15 mils.
- d. Approved equal.

C. Plastic Vapor Retarder: ASTM E 1745, Class C, or polyethylene sheet, ASTM D 4397, not less than 10 mils thick. Include manufacturer's recommended adhesive or pressure-sensitive joint tape.

1. Available Products:

- a. Fortifiber Corporation; Moistop Plus.
- b. Raven Industries Inc.; Dura Skrim 6.
- c. Reef Industries, Inc.; Griffolyn Type-65.
- d. Stego Industries, LLC; Stego Wrap, 10 mils.
- e. Approved equal.

D. Granular Fill: Clean mixture of crushed stone or crushed or uncrushed gravel; ASTM D 448, Size 57, with 100 percent passing a 1-1/2-inch sieve and 0 to 5 percent passing a No. 8 sieve.

- E. Fine-Graded Granular Material: Clean mixture of crushed stone, crushed gravel, and manufactured or natural sand; ASTM D 448, Size 10, with 100 percent passing a 3/8-inch sieve, 10 to 30 percent passing a No. 100 sieve, and at least 5 percent passing No. 200 sieve; complying with deleterious substance limits of ASTM C 33 for fine aggregates.

2.10 CURING MATERIALS

- A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.

- 1. Available Products:

- a. Axim Concrete Technologies; Cimfilm.
- b. Burke by Edoco; BurkeFilm.
- c. ChemMasters; Spray-Film.
- d. Conspec Marketing & Manufacturing Co., Inc., a Dayton Superior Company; Aquafilm.
- e. Dayton Superior Corporation; Sure Film.
- f. Euclid Chemical Company (The); Eucobar.
- g. Kaufman Products, Inc.; Vapor Aid.
- h. Lambert Corporation; Lambco Skin.
- i. L&M Construction Chemicals, Inc.; E-Con.
- j. MBT Protection and Repair, Div. of ChemRex; Confilm.
- k. Meadows, W. R., Inc.; Sealtight Evapre.
- l. Metalcrete Industries; Waterhold.
- m. Nox-Crete Products Group, Kinsman Corporation; Monofilm.
- n. Sika Corporation, Inc.; SikaFilm.
- o. Symons Corporation, a Dayton Superior Company; Finishing Aid.
- p. Unitex; Pro-Film.
- q. US Mix Products Company; US Spec Monofilm ER.
- r. Vexcon Chemicals, Inc.; Certi-Vex EnvioAssist.
- s. Approved equal.

- B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.

- C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

- D. Water: Potable.

- E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.

- 1. Available Products:

- a. Anti-Hydro International, Inc.; AH Curing Compound #2 DR WB.
 - b. Burke by Edoco; Aqua Resin Cure.
 - c. ChemMasters; Safe-Cure Clear.
 - d. Conspec Marketing & Manufacturing Co., Inc., a Dayton Superior Company; W.B. Resin Cure.
 - e. Dayton Superior Corporation; Day Chem Rez Cure (J-11-W).
 - f. Euclid Chemical Company (The); Kurez DR VOX.
 - g. Kaufman Products, Inc.; Thinfilm 420.
 - h. Lambert Corporation; Aqua Kure-Clear.
 - i. L&M Construction Chemicals, Inc.; L&M Cure R.
 - j. Meadows, W. R., Inc.; 1100 Clear.
 - k. Nox-Crete Products Group, Kinsman Corporation; Resin Cure E.
 - l. Symons Corporation, a Dayton Superior Company; Resi-Chem Clear Cure.
 - m. Tamms Industries, Inc.; Horncure WB 30.
 - n. Unitex; Hydro Cure 309.
 - o. US Mix Products Company; US Spec Maxcure Resin Clear.
 - p. Vexcon Chemicals, Inc.; Certi-Vex Enviocure 100.
 - q. Approved equal.
- F. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, 18 to 25 percent solids, nondissipating, certified by curing compound manufacturer to not interfere with bonding of floor covering.
- 1. Available Products:
 - a. Burke by Edoco; Spartan Cote WB II 20 Percent.
 - b. ChemMasters; Safe-Cure Clear.
 - c. Conspec Marketing & Manufacturing Co., Inc., a Dayton Superior Company; High Seal.
 - d. Dayton Superior Corporation; Safe Cure and Seal (J-19).
 - e. Euclid Chemical Company (The); Diamond Clear VOX.
 - f. Kaufman Products, Inc.; SureCure Emulsion.
 - g. Lambert Corporation; Glazecote Sealer-20.
 - h. L&M Construction Chemicals, Inc.; Dress & Seal WB.
 - i. MBT Protection and Repair, Div. of ChemRex; MasterKure-N-Seal VOC.
 - j. Meadows, W. R., Inc.; Vocomp-20.
 - k. Metalcrete Industries; Metcure 0800.
 - l. Nox-Crete Products Group, Kinsman Corporation; Cure & Seal 200E.
 - m. Sonneborn, Div. of ChemRex; Kure-N-Seal.
 - n. Symons Corporation, a Dayton Superior Company; Cure & Seal 18 Percent E.
 - o. Tamms Industries, Inc.; Clearseal WB STD.
 - p. Unitex; Hydro Seal 18.
 - q. US Mix Products Company; US Spec Radiance UV-25
 - r. Vexcon Chemicals, Inc.; Starseal 0800.
 - s. Approved equal.

G. Clear, Waterborne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A.

1. Available Products:

- a. Burke by Edoco; Cureseal 1315 WB.
- b. ChemMasters; Polyseal WB.
- c. Conspec Marketing & Manufacturing Co., Inc., a Dayton Superior Company; Sealcure 1315 WB.
- d. Euclid Chemical Company (The); Super Diamond Clear VOX.
- e. Kaufman Products, Inc.; Sure Cure 25 Emulsion.
- f. Lambert Corporation; UV Safe Seal.
- g. L&M Construction Chemicals, Inc.; Lumiseal WB Plus.
- h. Meadows, W. R., Inc.; Vocomp-30.
- i. Metalcrete Industries; Metcure 30.
- j. Symons Corporation, a Dayton Superior Company; Cure & Seal 31 Percent E.
- k. Tamms Industries, Inc.; LusterSeal WB 300.
- l. Unitex; Hydro Seal 25.
- m. US Mix Products Company; US Spec Radiance UV-25.
- n. Vexcon Chemicals, Inc.; Vexcon Starseal 1315.
- o. Approved equal.

2.11 RELATED MATERIALS

- A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber or ASTM D 1752, cork or self-expanding cork.
- B. Semirigid Joint Filler: Two-component, semirigid, 100 percent solids, epoxy resin with a Type A shore durometer hardness of 80 per ASTM D 2240.
- C. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.
- D. Epoxy resin bonding compounds to be used for wet areas : ASTM C881 Types IV or V, Class A, B, or C depending on temperature at use, and Grade to suit geometry and installation circumstances. Acceptable products include: BASF “Concresive Paste SPL” or “Concresive 1490”, as applicable; Sika Chemical Corporation “Sikadur 35” or Sikadur 32”, as applicable; or equal.
 1. Types I for bonding hardened or freshly mixed concrete to hardened concrete.

2.12 REPAIR MATERIALS

- A. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch and that can be feathered at edges to match adjacent floor elevations.
1. Cement Binder: ASTM C 150, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
 2. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
 3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by underlayment manufacturer.
 4. Compressive Strength: Not less than 4100 psi at 28 days when tested according to ASTM C 109/C 109M.
- B. Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch and that can be feathered at edges to match adjacent floor elevations.
1. Cement Binder: ASTM C 150, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
 2. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.
 3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by topping manufacturer.
 4. Compressive Strength: Not less than 5000 psi at 28 days when tested according to ASTM C 109/C 109M.
- C. Epoxy for Crack Injection: two-component, moisture insensitive, high modulus, injection grade, 100 percent solids, blend of epoxy-resin compounds. The consistency shall be as required to achieve complete penetration in hairline cracks and larger. Material shall conform to ASTM C881 Type 1 Grade 1. Acceptable products include Sika Corporation "Sikadur 52"; Adhesives Technology Corporation "Crackbond SLV302"; or approved equal. Epoxy grout shall be used for all crack repairs except as noted below for non-structural cracks in liquid-containing concrete. The Engineer shall determine whether a crack is classified as structural or non-structural. Structural cracks must be repaired with epoxy.
- D. Chemical Grout for Crack Injection: Chemical (hydrophobic polyurethane) grout shall be used at the Engineer's discretion as an alternative to the injection of the epoxy grout for sealing non-structural cracks in structures intended to be watertight. Acceptable products include "Hydro Active Flex SLV" by De Neef Construction Chemicals or SikaFix HH by Sika Corporation, or equal approved by the Engineer.

2.13 CONCRETE MIXTURES, GENERAL

- A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301. **Use Type V cement for Bar Screen.**

1. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.
- B. Cementitious Materials: Use fly ash, pozzolan, ground granulated blast-furnace slag, and silica fume as needed to reduce the total amount of portland cement. Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:
1. Pozzolan Class F Fly ash: 15-25 percent. See 2.14 for appropriate limits.
- C. Limit water-soluble, chloride-ion content in hardened concrete to 0.06 percent by weight of cement.
- D. Admixtures: Use admixtures according to manufacturer's written instructions.
1. Use water-reducing high-range water-reducing or plasticizing admixture in concrete, as required, for placement and workability.
 2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
 3. Use water-reducing admixture in pumped concrete, and concrete with a water-cementitious materials ratio below 0.50.
 4. Use corrosion-inhibiting admixture in concrete mixtures where indicated.

2.14 CONCRETE MIXTURES FOR BUILDING ELEMENTS

- A. Footings (buildings only): Proportion normal-weight concrete mixture as follows:
1. Minimum Compressive Strength: 4000 psi at 28 days.
 2. Maximum Water-Cementitious Materials Ratio: 0.50.
 3. Slump Limit: 4 inches, plus or minus 1 inch.
 4. Non air entrained.
- B. Liquid Containment Structures: Proportion normal-weight concrete mixture as follows:
1. Minimum Compressive Strength: 4000 psi at 28 days.
 2. Maximum Water-Cementitious Materials Ratio: 0.43.
 3. Limit pozzolan to 15-20% by weight of cementitious materials.
 4. Slump Limit: 4 inches, plus or minus 1 inch. Concrete containing high-range water-reducing admixture (superplasticizer): Not more than 8 inches after adding admixture to verified 4 inch maximum slump concrete.
 5. Air Content: 4%-6%
 6. Use no more than 5.1 gallons of water per bag of cementitious materials. This represents total water in the mix at time of mixing including free water on aggregates and water in admixture solution.

C. Slabs-on-Grade/Piers/Equipment pads: Proportion normal-weight concrete mixture as follows:

1. Minimum Compressive Strength: 4000 psi at 28 days.
2. Maximum Water-Cementitious Materials Ratio: 0.47.
3. Slump Limit: 4 inches, plus or minus 1 inch.
4. Air Content: 4-6%.
5. Air Content: Do not allow air content of troweled finished floors to exceed 3 percent.

2.15 FABRICATING REINFORCEMENT

A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

2.16 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M, and furnish batch ticket information.

1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.
2. Provide batch ticket for each batch discharged and used in the Work indicating Project identification name and number, date, mix type, time, quantity and amount of water.
3. No water shall be added at job site unless approved by Engineer in writing.

B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Mix concrete materials in appropriate drum-type batch machine mixer.

1. For mixer capacity of 1 cu. yd. or smaller, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released.
2. For mixer capacity larger than 1 cu. yd., increase mixing time by 15 seconds for each additional 1 cu. yd..
3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixture time, quantity, and amount of water added. Record approximate location of final deposit in structure.

PART 3 - EXECUTION

3.1 FORMWORK

- A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.
- B. Provide Class A for concrete surfaces exposed to view and inside of tank walls. Provide Class C for other concrete surfaces.
- C. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.
- D. Limit concrete surface irregularities, designated by ACI 347R as abrupt or gradual, as follows:
 - 1. Class A, 1/8 inch for smooth-formed finished surfaces.
 - 2. Class B, 1/4 inch Class C, 1/2 inch Class D, 1 inch for rough-formed finished surfaces.
- E. Construct forms tight enough to prevent loss of concrete mortar.
- F. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
 - 1. Install keyways, reglets, recesses, and the like, for easy removal.
 - 2. Do not use rust-stained steel form-facing material.
- G. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.
- H. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.
- I. Chamfer exterior corners and edges of permanently exposed concrete.
- J. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.

- K. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.
- L. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.
- M. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

3.2 EMBEDDED ITEMS

- A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 1. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC's "Code of Standard Practice for Steel Buildings and Bridges."
 - 2. Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.

3.3 REMOVING AND REUSING FORMS

- A. General: Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F for 24 hours after placing concrete, if concrete is hard enough to not be damaged by form-removal operations and curing and protection operations are maintained.
 - 1. Leave formwork for beam soffits, joists, slabs, and other structural elements that supports weight of concrete in place until concrete has achieved at least 70 percent of its 28-day design compressive strength.
 - 2. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.
- B. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.
- C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by Engineer.

3.4 VAPOR RETARDERS

- A. Plastic Vapor Retarders: Place, protect, and repair vapor retarders according to ASTM E 1643 and manufacturer's written instructions.
 - 1. Lap joints 6 inches and seal with manufacturer's recommended tape.
- B. Bituminous Vapor Retarders: Place, protect, and repair vapor retarders according to manufacturer's written instructions.

3.5 STEEL REINFORCEMENT

- A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.
 - 1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that would reduce bond to concrete.
- C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.
 - 1. Weld reinforcing bars according to AWS D1.4, where indicated.
- D. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.
- E. Install welded wire reinforcement in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.

3.6 JOINTS

- A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.
- B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Engineer. Wet the joint prior to subsequent pour. Remove any standing water prior to pour. See Section S3.7 for Concrete Placement at Liquid Retaining Structures.

1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints, unless otherwise indicated.
 2. Form keyed joints as indicated. Embed keys at least 1-1/2 inches into concrete.
- C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness as follows:
1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
 2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.
- D. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length to prevent concrete bonding to one side of joint.

3.7 CONCRETE PLACEMENT

- A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.
- B. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Engineer.
- C. Placement Sequence – To minimize the effect of shrinkage in producing cracks, all liquid retaining structures shall be constructed using a placement sequence. For these structures, concrete shall be placed as follows:
1. Bottom slab. Each bottom slab shall be divided into sections by the construction joints indicated on the drawings and, when not indicated on the drawings. Bottom slabs with radial and circumferential reinforcement patterns may be divided into pie shaped segments. A section near the center shall be placed first. Sections shall be placed alternately, first on one side and then on the other side of previously placed sections. Placement shall be scheduled so that two adjacent sides of each section are free, except at closures.
 2. Walls. Walls shall be divided into sections by the construction joints indicated on the drawings. Top Slabs. Each top slab shall be placed in the manner subscribed for the bottom slab.

No two abutting sections shall be placed within a period of 48 hours, unless otherwise authorized by the Engineer.

- D. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.
1. Deposit concrete in horizontal layers of depth to not exceed formwork design pressures and in a manner to avoid inclined construction joints.
 2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.
 3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.
- E. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.
1. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
 2. Maintain reinforcement in position on chairs during concrete placement.
 3. Screed slab surfaces with a straightedge and strike off to correct elevations.
 4. Slope surfaces uniformly to drains where required.
 5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.
- F. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
1. When average high and low temperature is expected to fall below 40 deg F for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
 2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
 3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.
- G. Hot-Weather Placement: Comply with ACI 301 and as follows:
1. Maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water

equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.

2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

3.8 FINISHING FORMED SURFACES

- A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
 1. Apply to concrete surfaces not exposed to view (inside of tanks below water level shall have a Smooth- Formed Finish).
- B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
 1. Apply to concrete surfaces to receive a rubbed finish, visible surfaces inside of tanks to 1 foot below water level, or concrete to be covered with a coating or covering material applied directly to concrete.
- C. Rubbed Finish: Apply the following to smooth-formed finished as-cast concrete to all concrete surfaces exposed to view including inside of tank walls above the water level:
 1. Smooth-Rubbed Finish: Not later than one day after form removal, moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.
 2. Grout-Cleaned Finish: Wet concrete surfaces and apply grout of a consistency of thick paint to coat surfaces and fill small holes. Mix one part portland cement to one and one-half parts fine sand with a 1:1 mixture of bonding admixture and water. Add white portland cement in amounts determined by trial patches so color of dry grout will match adjacent surfaces. Scrub grout into voids and remove excess grout. When grout whitens, rub surface with clean burlap and keep surface damp by fog spray for at least 36 hours.
 3. Cork-Floated Finish: Wet concrete surfaces and apply a stiff grout. Mix one part portland cement and one part fine sand with a 1:1 mixture of bonding agent and water. Add white portland cement in amounts determined by trial patches so color of dry grout will match adjacent surfaces. Compress grout into voids by grinding surface. In a swirling motion, finish surface with a cork float.
- D. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces except at walkways. Continue final surface

treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.

3.9 FINISHING FLOORS AND SLABS

- A. General: Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.
- B. Scratch Finish: While still plastic, texture concrete surface that has been screeded and bull-floated or darbied. Use stiff brushes, brooms, or rakes to produce a profile amplitude of 1/4 inch in 1 direction. After placing slabs, finish surface to tolerances of F(F) 15 (floor flatness and F(L) 13 (floor levelness) measured according to ASTM E1155.
 - 1. Apply scratch finish to surfaces to receive mortar setting beds for bonded cementitious floor finishes or for concrete to receive a grouted overlay for slope. Slope surfaces uniformly to drains where required.
- C. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture.
 - 1. Apply float finish to surfaces to receive trowel finish, bottom of tanks (except clarifiers or other tanks to receive grout), and concrete to be covered with fluid-applied or sheet waterproofing, built-up or membrane roofing, or sand-bed terrazzo.
- D. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
 - 1. Apply a trowel finish to surfaces exposed to view, grouted bottom of clarifiers, or to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin-film-finish coating system
 - 2. Finish surfaces to the following tolerances, according to ASTM E 1155, for a randomly trafficked floor surface:
 - a. Specified overall values of flatness, F(F) 25; and of levelness, F(L) 20; with minimum local values of flatness, F(F) 17; and of levelness, F(L) 15.
 - 3. Finish and measure surface so gap at any point between concrete surface and an unveled, freestanding, 10-foot- long straightedge resting on 2 high spots and placed anywhere on the surface does not exceed 1/4 inch

- E. Trowel and Fine-Broom Finish: Apply a first trowel finish to surfaces where ceramic or quarry tile is to be installed by either thickset or thin-set method. While concrete is still plastic, slightly scarify surface with a fine broom.
 - 1. Comply with flatness and levelness tolerances for trowel finished floor surfaces.
- F. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, walkways at top of tanks and ramps, and elsewhere as indicated.
 - 1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Engineer before application.

3.10 MISCELLANEOUS CONCRETE ITEMS

- A. Filling In: Fill in holes and openings left in concrete structures, unless otherwise indicated, after work of other trades is in place. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.
- B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.
- C. Equipment Bases and Foundations: Provide machine and equipment bases and foundations as shown on Drawings. Set anchor bolts for machines and equipment at correct elevations, complying with diagrams or templates from manufacturer furnishing machines and equipment.
- D. Steel Pan Stairs: Provide concrete fill for steel pan stair treads, landings, and associated items. Cast-in inserts and accessories as shown on Drawings. Screed, tamp, and trowel-finish concrete surfaces.

3.11 CONCRETE PROTECTING AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 for hot-weather protection during curing.
- B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

- C. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue moist curing for the remainder of the curing period.
- D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.
- E. Cure concrete according to ACI 308.1, by one or a combination of the following methods:
 - 1. Moisture Curing: Provide moisture curing for all liquid retaining structures. Keep surfaces continuously moist for not less than seven days with the following materials:
 - a. Water.
 - b. Continuous water-fog spray.
 - c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.
 - 2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
 - a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.
 - b. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.
 - c. Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer certifies will not interfere with bonding of floor covering used on Project.
 - 3. Curing Compound: Apply curing compound on exposed interior slabs and on exterior slabs, walks and curbs. Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.
 - a. After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer unless manufacturer certifies curing compound will not interfere with bonding of floor covering used on Project.
 - 4. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial

application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

3.12 JOINT FILLING

- A. Prepare, clean, and install joint filler according to manufacturer's written instructions.
 - 1. Defer joint filling until concrete has aged at least one month. Do not fill joints until construction traffic has permanently ceased.
- B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joint clean and dry.
- C. Install semirigid joint filler full depth in saw-cut joints and at least 2 inches deep in formed joints. Overfill joint and trim joint filler flush with top of joint after hardening.

3.13 CONCRETE SURFACE REPAIRS

- A. Defective Concrete: Repair and patch defective areas when approved by Engineer. Remove and replace concrete that cannot be repaired and patched to Engineer's approval.
- B. Patching Mortar: Mix dry-pack patching mortar, consisting of one part portland cement to two and one-half parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.
- C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.
 - 1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension in solid concrete, but not less than 1 inch in depth. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
 - 2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement so that, when dry, patching mortar will match surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.
 - 3. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Engineer.

- D. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.
1. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
 2. After concrete has cured at least 14 days, correct high areas by grinding.
 3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.
 4. Correct other low areas scheduled to receive floor coverings with a repair underlayment. Prepare, mix, and apply repair underlayment and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.
 5. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch to match adjacent floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
 6. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least a 3/4-inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mixture as original concrete except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
 7. Repair random cracks and single holes 1 inch or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.
- E. Perform structural repairs of concrete, subject to Engineer's approval, using epoxy adhesive and patching mortar.
- F. Repair materials and installation not specified above may be used, subject to Engineer's approval.

3.14 FIELD QUALITY CONTROL

- A. Testing and Inspecting: Contractor shall engage a qualified testing agency to perform tests and to submit reports.
- B. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:
 - 1. Retain subparagraph above or below. Above is an example that produces more frequent testing than below, which is testing frequency required to comply with ACI 301.
 - 2. Testing Frequency: Obtain at least one composite sample for each 50 cu. yd. or fraction thereof of each concrete mixture placed each day.
 - a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
 - 3. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
 - 4. Air Content: ASTM C 231, pressure method, for normal-weight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
 - 5. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F and below and when 80 deg F and above, and one test for each composite sample.
 - 6. Compression Test Specimens: ASTM C 31/C 31M.
 - a. Cast and laboratory cure two sets of two standard cylinder specimens for each composite sample.
 - b. Cast and field cure two sets of two standard cylinder specimens for each composite sample.
 - 7. Compressive-Strength Tests: ASTM C 39/C 39M; test one laboratory-cured or field-cured specimens at 7 days and one set of two specimens at 28 days. Hold one cylinder for 56 day break if necessary.
 - a. A compressive-strength test shall be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.
 - 8. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.
 - 9. Test results shall be reported in writing to Engineer, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name

of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

10. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device (Windsor Probe not Swiss Hammer) may be permitted by Engineer but will not be used as sole basis for acceptance or rejection of concrete.
 11. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Engineer. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42/C 42M or by other methods as directed by Engineer.
 12. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
 13. Correct deficiencies in the Work that test reports and inspections indicate does not comply with the Contract Documents.
- C. Measure floor and slab flatness and levelness according to ASTM E 1155 within 48 hours of finishing.

END OF SECTION

SECTION 03 60 00

NON-SHRINK GROUT

PART 1 - GENERAL

1.1 SCOPE

- A. Under this heading shall be included the furnishing and installation of non-shrink grouts. Non-shrink grouts shall be used for the following types of work: setting anchor bolts and dowels in pre-drilled holes; setting base plates, bearing plates, crane rails, handrails, and machinery bases; setting or joining precast concrete elements; and for patching and repair of all watertight structures. Non-shrink grout shall also be used for patching and repair of precast and/or prestressed concrete work, and other grouting work where specifically noted on the Contract Plans.
- B. Included is all labor, materials, equipment, tools and energy necessary to accomplish the grouting work.

1.2 RELATED WORK SPECIFIED IN OTHER SECTIONS

- A. Patching and repair of concrete surfaces, where non-shrink grout is not specified nor noted on the Contract Plans, is included under Cast-in-Place Concrete, Section 033000.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Non-Shrink/Non-Metallic Grout (Type "A")
 - 1. Grout shall be factory-mixed containing natural aggregates formulated to be used at any consistency from extremely fluid to damp pack (Plastic). The grout shall be similar in finished appearance to adjacent concrete or mortar. The grout shall be free of gas producing agents, oxidizing catalysts and inorganic accelerators.

2. The compressive strength of the grout in-place, when placed in a plastic consistency, shall meet, or exceed the following:

4,000 psi	at 1 Day
6,000 psi	at 3 Days
7,500 psi	at 7 Days
9,500 psi	at 28 Days

Grout placed in a fluid consistency shall meet or exceed an in-place, twenty-eight-day (28) compressive strength of at least 15 percent (15%) greater than the required concrete strength specified, or 5,000 psi, which ever is greater.

B. Non-Shrink/Metallic Aggregate Grout Type "B"

1. Grout shall be factory-mixed, containing specially graded and processed ferrous metallic aggregate and graded natural aggregates with a cementitious system formulated to be used at any consistency from extremely fluid to damp pack. The grout shall be free of gas producing agents, oxidizing agents and organic accelerators.
2. The compressive strength of the grout in-place, when placed in a plastic consistency, shall meet or exceed the following:

4,000 psi	at 1 Day
6,000 psi	at 3 Days
8,000 psi	at 7 Days
10,000 psi	at 28 Days

3. Grout placed in a fluid consistency shall have an in-place, twenty-eight-day (28) compressive strength of not less than 7,000 psi.

C. Water

1. Water shall be potable.

PART 3 - EXECUTION

3.1 GROUTING SCHEDULE

- A. Grouting under this Contract shall be done in accordance with the applicable items in the following schedule, unless noted otherwise:

Grouting Applications	Grout Type*
Anchor bolts and dowels in cast or drilled holes	"B"
Column base plates	"A"
Bearing plates	"A"
Concrete surface repair and patch work	"A"
Crane rails	"B"
Metal handrails	"A"
Setting and joining precast concrete elements	"A"
Machinery bases	"B"

- B. Type "A" grout shall be used for all applications where grout will be exposed to salt water, brackish water, salt water spray or corrosive environment.

3.2 GROUT CONSISTENCY

- A. Grout may be placed in a damp pack (plastic) or flowable (fluid) consistency to suit job conditions and as specified herein; however, grout shall be placed in a damp pack (Plastic) consistency wherever possible to provide the highest strength grout.
- B. Damp pack (plastic) grout shall be used for grouting vertical surfaces with holes having at least one surface dimension less than the hole depth and for holes left by removal of fasteners and form ties. Damp pack (plastic) grout may be used for column base plates,

bearing plates, machinery bases and precast concrete elements where either horizontal dimension of the element being grouted is less than 16 inches.

- C. Flowable or fluid grout shall be used for all other applications.

3.3 SURFACE PREPARATION

A. General

1. Concrete surfaces to receive grout shall be rough and reasonably level. Laitance shall be removed to sound concrete. The surfaces, including bolt holes shall be saturated with water for twenty-four (24) hours prior to grouting, unless otherwise recommended by the grouting manufacturer.
2. Where grout is to be used to repair damaged concrete surfaces, the damaged or honeycombed concrete shall be removed to sound concrete by chipping.
3. Metal surfaces to receive grout shall be derusted, cleaned of oil, grease and other deleterious substances by means of appropriate solvents, wire brushing or a combination of both.

B. Formwork

1. Forms shall be provided for grout placed at a flowable (fluid) consistency.
2. Forms shall be strong, tight and shall be braced so they will not leak or buckle under the weight of fluid grout. On the placing side, forms shall extend 3 inches from base plate, unless otherwise indicated, and shall slant at a 45 degree angle. Grout shall be poured directly on the slanted face. On other sides, the form shall be placed \square - inch or more away from base of the bedplate and 1 inch or more higher than the underside of the plate.
 - a. Forms shall be caulked with grout or a sand-cement mortar to prevent leakage. Expanded polystyrene or other means shall be used to caulk between foundation and portions of the element being grouted to seal off areas where grout is not required.
 - b. Provide air relief openings to avoid entrapment of air.

3.4 GROUT PREPARATION, PLACEMENT AND CURING

- A. Grout shall be mixed to proper consistency, placed, and cured as instructed by the grout manufacturer. A paddle-type mortar mixer or other suitable mechanical mixer shall be used unless otherwise allowed.
- B. Any nearby vibrating machinery or equipment should be shut down to avoid disturbing the bonding or initial set of freshly placed grout.
- C. Mixing water temperature shall not be less than 40 Degrees F. nor exceed 80 degrees F. unless more stringent conditions are required by the grout manufacturer.
- D. Grout shall be placed at a temperature of 65 to 75 Degrees; and maintained at this temperature range for twenty-four (24) hours, and above 40 Degrees F. thereafter until the grout strength exceeds 4,000 psi.
- E. Grout used for concrete surface repair and patchwork shall be applied to a small area and allowed to cure to determine color compatibility (subject to Engineer's review).

END OF SECTION

SECTION 042000 - UNIT MASONRY ASSEMBLIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes unit masonry assemblies consisting of the following:

1. Concrete masonry units (CMUs).
2. Face brick.
3. Mortar and grout.
4. Reinforcing steel.
5. Masonry joint reinforcement.
6. Ties and anchors.
7. Embedded flashing.
8. Miscellaneous masonry accessories.
9. Cavity-wall insulation.
10. Decorative CMU units.

- B. Related Sections include the following:

1. Division 7 Section "Bituminous Dampproofing" for dampproofing applied to cavity face of backup wythes of cavity walls.
2. Division 7 Section "Sheet Metal Flashing and Trim" for exposed sheet metal flashing.
3. Division 7 Section "Through-Penetration Firestop Systems" for firestopping at openings in masonry walls.
4. Division 7 Section "Fire-Resistive Joint Systems" for fire-resistive joint systems at heads of masonry walls.
5. Division 7 Section "Joint Sealants" for sealing control and expansion joints in unit masonry.
6. Division 8 Section "Louvers" for wall vents (brick vents).

- C. Products installed, but not furnished, under this Section include the following:

1. Cast-stone trim, furnished under Division 4 Section "Cast Stone."
2. Steel lintels and shelf angles for unit masonry, furnished under Division 5 Section "Metal Fabrications."
3. Manufactured reglets in masonry joints for metal flashing, furnished under Division 7 Section "Sheet Metal Flashing and Trim."

1.3 DEFINITIONS

- A. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells.

1.4 PERFORMANCE REQUIREMENTS

- A. Provide structural unit masonry that develops a net-area compressive strengths (f'_m) of 1900 psi at 28 days.
- B. Determine net-area compressive strength (f'_m) of masonry by testing masonry prisms according to ASTM C 1314.

1.5 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For the following:
 - 1. Masonry Units: Show sizes, profiles, coursing, and locations of special shapes.
 - 2. Reinforcing Steel: Detail bending and placement of unit masonry reinforcing bars. Comply with ACI 315, "Details and Detailing of Concrete Reinforcement." Show elevations of reinforced CMU walls with all reinforcement shown including bond beams, opening reinforcing, etc. and control joints.
 - 3. Fabricated Flashing: Detail corner units, end-dam units, and other special applications.
- C. Samples for Initial Selection: For the following:
 - 1. Face brick, in the form of straps of five or more bricks.
 - 2. Colored mortar.
 - 3. Weep holes/vents.
 - 4. Decorative CMU.
- D. Samples for Verification: For each type and color of the following:
 - 1. Face brick, in the form of straps of five or more bricks.
 - 2. Special brick shapes.
 - 3. Pigmented and colored-aggregate mortar. Make Samples using same sand and mortar ingredients to be used on Project. Label Samples to indicate types and amounts of pigments used.
 - 4. Weep holes/vents.
 - 5. Accessories embedded in masonry.
 - 6. Decorative CMU.
 - 7. Special CMU shapes.

- E. Material Certificates: Include statements of material properties indicating compliance with requirements including compliance with standards and type designations within standards. Provide for each type and size of the following:
1. Masonry units.
 - a. Include material test reports substantiating compliance with requirements.
 - b. For bricks, include size-variation data verifying that actual range of sizes falls within specified tolerances.
 - c. For exposed brick, include material test report for efflorescence according to ASTM C 67.
 - d. For masonry units used in structural masonry, include data and calculations establishing average net-area compressive strength of units.
 2. Cementitious materials. Include brand, type, and name of manufacturer.
 3. Preblended, dry mortar mixes. Include description of type and proportions of ingredients.
 4. Grout mixes. Include description of type and proportions of ingredients.
 5. Reinforcing bars.
 6. Joint reinforcement.
 7. Anchors, ties, and metal accessories.
- F. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.
1. Include test reports, per ASTM C 780 for mortar mixes required to comply with property specification.
 2. Include test reports, per ASTM C 1019 for grout mixes required to comply with compressive strength requirement.
- G. Statement of Compressive Strength of Masonry: For each combination of masonry unit type and mortar type, provide statement of average net-area compressive strength of masonry units, mortar type, and resulting net-area compressive strength of masonry determined according to Tables 1 and 2 in ACI 530.1/ASCE 6/TMS 602.
- H. Hot-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with cold-weather requirements.
- I. Cold-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with cold-weather requirements.

1.6 QUALITY ASSURANCE

- A. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, through one source from a single manufacturer for each product required.
- B. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from a single manufacturer for each cementitious component and from one source or producer for each aggregate.
- C. Fire-Resistance Ratings: Where indicated, provide materials and construction identical to those of assemblies with fire-resistance ratings determined per ASTM E 119 by a testing and inspecting agency, by equivalent concrete masonry thickness, or by other means, as acceptable to authorities having jurisdiction.
- D. Mockup: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 - 1. Build mockups for a complete assembly of a typical exterior wall, 12 feet long by 12 feet high by full thickness, including stud wall framing, sheathing, vapor barrier, air space, and masonry veneer.
 - a. Include a complete window assembly, including head, jamb, and sill installations.
 - b. Include thru-wall flashing.
 - c. Include masonry lintels.
 - d. Include veneer anchors, flashing, and weep holes in exterior masonry-veneer wall mockup.
 - e. Include all masonry veneer types. Provide masonry veneer only over half of the mock up assembly, leaving half of the mock up wall cavity exposed for visibility.
 - f. Include complete installation of overhead coiling shutter
 - g. Include a sealant-filled joint at least 16 inches long.
 - 2. Clean one-half of exposed faces of mockups with masonry cleaner as indicated.
 - 3. Protect accepted mockups from the elements with weather-resistant membrane.
 - 4. Approval of mockups is for color, texture, and blending of masonry units; relationship of mortar and sealant colors to masonry unit colors; tooling of joints; and aesthetic qualities of workmanship.
 - a. Approval of mockups is also for other material and construction qualities specifically approved by Design Professional in writing.
 - b. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless such deviations are specifically approved by Design Professional in writing.
- E. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."
- F. Coordinate Construction with Special Inspector.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.
- B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
- C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.
- D. Deliver preblended, dry mortar mix in moisture-resistant containers designed for lifting and emptying into dispensing silo. Store preblended, dry mortar mix in delivery containers on elevated platforms, under cover, and in a dry location or in a metal dispensing silo with weatherproof cover.
- E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.8 PROJECT CONDITIONS

- A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.
 - 1. Extend cover a minimum of 24 inches down both sides and hold cover securely in place.
 - 2. Where 1 wythe of multiwythe masonry walls is completed in advance of other wythes, secure cover a minimum of 24 inches down face next to unconstructed wythe and hold cover in place.
- B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least 3 days after building masonry walls or columns.
- C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.
 - 1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
 - 2. Protect sills, ledges, and projections from mortar droppings.
 - 3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
 - 4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.
- D. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F and above and will remain so until masonry has dried, but not less than 7 days after completing cleaning.
- E. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
1. Products: Subject to compliance with requirements, provide one of the products specified.
 2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 MASONRY UNITS, GENERAL

- A. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to exceed tolerances and to contain chips, cracks, or other defects exceeding limits stated in the standard. Do not use units where such defects, including dimensions that vary from specified dimensions by more than stated tolerances, will be exposed in the completed Work or will impair the quality of completed masonry.

2.3 CONCRETE MASONRY UNITS (CMUs)

- A. Shapes: Provide shapes indicated and as follows:
1. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.
 2. Provide bull-nose units for outside corners in interior spaces, unless otherwise indicated.
 - a. Provide square-edge units at the first course at floor level and bull-nose units for each course above the first.
- B. Concrete Masonry Units: ASTM C 90.
1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 1900 psi.
 2. Weight Classification: Lightweight.
 3. Size (Width): As indicated on drawings. Manufactured to dimensions 3/8 inch less than nominal dimensions.
- C. Decorative Concrete Masonry Units: ASTM C 90.

1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 1900 psi.
2. Weight Classification: Lightweight.
3. Size (Width): As indicated on drawings. Manufactured to dimensions specified in "Concrete Masonry Units" Paragraph above.
4. Pattern and Texture:
 - a. Standard pattern, ground finish.
5. Colors: Match Design Professional's sample.

2.4 CONCRETE AND MASONRY LINTELS

- A. General: Provide concrete complying with requirements below.
- B. Concrete Lintels: Precast units made from concrete matching concrete masonry units in color, texture, and compressive strength and with reinforcing bars indicated or required to support loads indicated. Cure precast lintels by same method used for concrete masonry units. Use Lott's Concrete lintels or equal.
- C. Masonry Lintels: Prefabricated or built-in-place masonry lintels made from U shaped block with bond beam concrete masonry units with reinforcing bars placed as indicated and filled with coarse grout. Cure precast lintels before handling and installing. Temporarily support built-in-place lintels until cured.

2.5 BRICK

- A. General: Provide shapes indicated and as follows:
 1. For ends of sills and caps and for similar applications that would otherwise expose unfinished brick surfaces, provide units without cores or frogs and with exposed surfaces finished.
 2. Provide special shapes for applications where stretcher units cannot accommodate special conditions, including those at corners, movement joints, bond beams, sashes, and lintels.
 3. Provide special shapes for applications requiring brick of size, form, color, and texture on exposed surfaces that cannot be produced by sawing.
 4. Provide special shapes for applications where shapes produced by sawing would result in sawed surfaces being exposed to view.
- B. Face Brick: ASTM C 216 UBC, Grade SW, Type FBS.
 1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 3000psi.
 2. Initial Rate of Absorption: Less than 30 g/30 sq. in. per minute when tested per ASTM C 67.
 3. Efflorescence: Provide brick that has been tested according to ASTM C 67 and is rated "not effloresced."
 4. Size: Modular, 7-5/8"x3-5/8"x2-1/4". Install in running bond pattern.

5. Color and Texture:
 - a. Brick 1: Cherokee, see Drawings.
 - b. Additional Manufacturers:
 - 1) Boral
 - 2) Acme

2.6 MORTAR AND GROUT MATERIALS

- A. Portland Cement: ASTM C 150, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.
- B. Hydrated Lime: ASTM C 207, Type S.
- C. Portland Cement-Lime Mix: Packaged blend of portland cement complying with ASTM C 150, Type I or Type III, and hydrated lime complying with ASTM C 207, Type S.
- D. Masonry Cement: ASTM C 91.
 1. Products:
 - a. Lafarge North America Inc.; Magnolia Masonry Cement or Lafarge Masonry Cement.
 - b. Cemex.
 - c. Old Castle.
- E. Mortar Cement: ASTM C 1329.
 1. Products:
 - a. Lafarge North America Inc.; Lafarge Mortar Cement or Magnolia Superbond Mortar Cement.
 - b. Cemex.
 - c. Old Castle.
- F. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes. Use only pigments with a record of satisfactory performance in masonry mortar.
 1. Products:
 - a. Bayer Corporation, Industrial Chemicals Div.; Bayferrox Iron Oxide Pigments.
 - b. Davis Colors; True Tone Mortar Colors.
 - c. Solomon Grind-Chem Services, Inc.; SGS Mortar Colors.
 - d. Cemex.
- G. Colored Cement Product: Packaged blend made from portland cement and lime masonry cement or mortar cement and mortar pigments, all complying with specified requirements, and containing no other ingredients.
 1. Formulate blend as required to produce color indicated or, if not indicated, as selected from manufacturer's standard colors.

2. Pigments shall not exceed 10 percent of portland cement by weight.
3. Pigments shall not exceed 5 percent of masonry cement or mortar cement by weight.
4. Available Products:
 - a. Colored Portland Cement-Lime Mix:
 - 1) Capital Materials Corporation; Riverton Portland Cement Lime Custom Color.
 - 2) Holcim (US) Inc.; Rainbow Mortamix Custom Color Cement/Lime.
 - 3) Lafarge North America Inc.; Eaglebond.
 - 4) Lehigh Cement Company; Lehigh Custom Color Portland/Lime Cement.
 - 5) Cemex.
 - b. Colored Masonry Cement:
 - 1) Capital Materials Corporation; Flamingo Color Masonry Cement.
 - 2) Essroc, Italcementi Group; Brixment-in-Color.
 - 3) Holcim (US) Inc.; Rainbow Mortamix Custom Color Masonry Cement.
 - 4) Lafarge North America Inc.; Magnolia Masonry Cement.
 - 5) Lehigh Cement Company; Lehigh Custom Color Masonry Cement.
 - 6) National Cement Company, Inc.; Coosa Masonry Cement.
 - 7) Cemex.
 - c. Colored Mortar Cement:
 - 1) Lafarge North America Inc.; Magnolia Superbond Mortar Cement.
 - 2) Cemex.
 - 3) Old Castle.

H. Aggregate for Mortar: ASTM C 144.

1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.
2. For joints less than 1/4 inch thick, use aggregate graded with 100 percent passing the No. 16 sieve.
3. White-Mortar Aggregates: Natural white sand or crushed white stone.
4. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.

I. Aggregate for Grout: ASTM C 404.

J. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C 494/C 494M, Type C, and recommended by manufacturer for use in masonry mortar of composition indicated.

1. Products:
 - a. Addiment Incorporated; Mortar Kick.
 - b. Euclid Chemical Company (The); Accelguard 80.
 - c. Grace Construction Products, a unit of W. R. Grace & Co. - Conn.; Morset.
 - d. Sonneborn, Div. of ChemRex; Trimix-NCA.

K. Water-Repellent Admixture: Liquid water-repellent mortar admixture intended for use with concrete masonry units, containing integral water repellent by same manufacturer.

1. Products:

- a. Addiment Incorporated; Mortar Tite.
- b. Grace Construction Products, a unit of W. R. Grace & Co. - Conn.; Dry-Block Mortar Admixture.
- c. Master Builders, Inc.; Color Cure Mortar Admix or Rheomix Rheopel.

L. Water: Potable.

2.7 REINFORCEMENT

A. Uncoated Steel Reinforcing Bars: ASTM A 615/A 615M or ASTM A 996/A 996M, Grade 60.

B. Masonry Joint Reinforcement, General: ASTM A 951.

1. Interior Walls: Hot-dip galvanized, carbon steel.
2. Exterior Walls: Hot-dip galvanized, carbon steel.
3. Wire Size for Side Rods: 0.148-inch diameter.
4. Wire Size for Cross Rods: W1.7 or 0.148-inch diameter.
5. Wire Size for Veneer Ties: W1.7 or 0.148-inch diameter.
6. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than 16 inches o.c.
7. Provide in lengths of not less than 10 feet, with prefabricated corner and tee units.

C. Masonry Joint Reinforcement for Single-Wythe Masonry: Either ladder or truss type with single pair of side rods.

D. Masonry Joint Reinforcement for Veneers Anchored with Seismic Masonry-Veneer Anchors: Single 0.188-inch- diameter, hot-dip galvanized, carbon steel continuous wire.

2.8 TIES AND ANCHORS

A. Materials: Provide ties and anchors specified in subsequent paragraphs that are made from materials that comply with eight subparagraphs below, unless otherwise indicated.

1. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A 82; with ASTM A 153/A 153M, Class B-2 coating.
2. Galvanized Steel Sheet: ASTM A 653/A 653M, Commercial Steel, G60 zinc coating.
3. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

B. Wire Ties, General: Unless otherwise indicated, size wire ties to extend at least halfway through veneer but with at least 5/8-inch cover on outside face. Outer ends of wires are bent 90 degrees and extend 2 inches parallel to face of veneer.

C. Individual Wire Ties: Rectangular units with closed ends and not less than 4 inches wide.

1. Z-shaped ties with ends bent 90 degrees to provide hooks not less than 2 inches long may be used for masonry constructed from solid units or hollow units laid with cells horizontal.
2. Where wythes do not align or are of different materials, use adjustable ties with pintle-and-eye connections having a maximum adjustment of 1-1/4 inches.
3. Wire: Fabricate from 3/16-inch-, hot-dip galvanized steel wire.

D. Adjustable Masonry-Veneer Anchors

1. General: Provide anchors that allow vertical adjustment but resist tension and compression forces perpendicular to plane of wall, for attachment over sheathing to wood or metal studs, and as follows:
 - a. Structural Performance Characteristics: Capable of withstanding a 100-lbf load in both tension and compression without deforming or developing play in excess of 0.05 inch.
2. Seismic Masonry-Veneer Anchors: Units consisting of a metal anchor section and a connector section designed to engage a continuous wire embedded in the veneer mortar joint.
 - a. Anchor Section: Rib-stiffened, sheet metal plate with screw holes top and bottom, 2-3/4 inches wide by 3 inches high; with projecting tabs having slotted holes for inserting vertical legs of wire tie specially formed to fit anchor section. Size wire tie to extend at least 1-1/2 inches into veneer but with at least 5/8-inch cover on outside face.
 - b. Connector Section: Sheet metal clip welded to wire tie with integral tabs designed to engage continuous wire.
 - c. Fabricate sheet metal anchor sections and other sheet metal parts from 0.067-inch-thick, steel sheet, galvanized after fabrication
 - d. Fabricate wire connector sections from 0.25-inch- diameter, hot-dip galvanized, carbon steel wire.
 - e. Products:
 - 1) Dayton Superior Corporation, Dur-O-Wal Division; D/A 213S.
 - 2) Hohmann & Barnard, Inc.; DW-10-X-Seismicclip.
 - 3) Wire-Bond; RJ-711 with Wire-Bond clip.
3. Stainless-Steel Drill Screws for Steel Studs: Proprietary fastener consisting of carbon-steel drill point and 300 Series stainless-steel shank, complying with ASTM C 954 except manufactured with hex washer head and neoprene washer, No. 10 diameter by length required to penetrate steel stud flange with not less than three exposed threads.
 - a. Products:
 - 1) Dayton Superior Corporation, Dur-O-Wal Division; Stainless Steel SX Fastener.
 - 2) ITW Buildex; Scots long life Tek.
 - 3) Other pre-approved equal.

2.9 MISCELLANEOUS ANCHORS

- A. Unit Type Inserts in Concrete: Cast-iron or malleable-iron wedge-type inserts.
- B. Dovetail Slots in Concrete: Furnish dovetail slots with filler strips, of slot size indicated, fabricated from 0.034-inch, galvanized steel sheet.
- C. Anchor Bolts: Headed steel bolts complying with ASTM A 307, Grade A; with ASTM A 563 hex nuts and, where indicated, flat washers; hot-dip galvanized to comply with ASTM A 153/A 153M, Class C; of dimensions indicated.
- D. Postinstalled Anchors: Provide chemical or torque-controlled expansion anchors, with capability to sustain, without failure, a load equal to six times the load imposed when installed in solid or grouted unit masonry and equal to four times the load imposed when installed in concrete, as determined by testing per ASTM E 488 conducted by a qualified independent testing agency.
 - 1. Corrosion Protection: Carbon-steel components zinc plated to comply with ASTM B 633, Class Fe/Zn 5 (5 microns) for Class SC 1 service condition (mild).

2.10 EMBEDDED FLASHING MATERIALS

- 1. EPDM Flashing: Sheet flashing product made from ethylene-propylene-diene terpolymer, complying with ASTM D 4637, 0.040 inch thick.
 - a. Products:
 - 1) Carlisle Coatings & Waterproofing; Pre-Kleened EPDM Thru-Wall Flashing.
 - 2) Firestone Building Products; FlashGuard.
 - 3) Heckmann Building Products Inc.; No. 81 EPDM Thru-Wall Flashing.
- B. Solder and Sealants for Sheet Metal Flashings: As specified in Division 7 Section "Sheet Metal Flashing and Trim."
 - 1. Elastomeric Sealant: ASTM C 920, chemically curing silicone sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.
- C. Adhesives, Primers, and Seam Tapes for Flashings: Flashing manufacturer's standard products or products recommended by flashing manufacturer for bonding flashing sheets to each other and to substrates.

2.11 MISCELLANEOUS MASONRY ACCESSORIES

- A. Compressible Filler: Premolded filler strips complying with ASTM D 1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene urethane or PVC.
- B. Preformed Control-Joint Gaskets: Made from styrene-butadiene-rubber compound, complying with ASTM D 2000, Designation M2AA-805 or PVC, complying with ASTM D 2287,

Type PVC-65406 and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.

- C. Bond-Breaker Strips: Asphalt-saturated, organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt).
- D. Weep/Vent Products: Use one of the following, unless otherwise indicated:
 - 1. Wicking Material: Absorbent rope, made from cotton or UV-resistant synthetic fiber, 1/4 to 3/8 inch in diameter, in length required to produce 2-inch exposure on exterior and 18 inches in cavity between wythes. Use only for weeps.
 - 2. Round Plastic Weep/Vent Tubing: Medium-density polyethylene, 3/8-inch OD by 4 inches long.
 - 3. Rectangular Plastic Weep/Vent Tubing: Clear butyrate, 3/8 by 1-1/2 by 3-1/2 inches long.
 - 4. Cellular Plastic Weep/Vent: One-piece, flexible extrusion made from UV-resistant polypropylene copolymer, full height and width of head joint and depth 1/8 inch less than depth of outer wythe, in color selected from manufacturer's standard.
 - a. Products:
 - 1) Advanced Building Products Inc.; Mortar Maze weep vent.
 - 2) Dayton Superior Corporation, Dur-O-Wal Division; Cell Vents.
 - 3) Heckmann Building Products Inc.; No. 85 Cell Vent.
 - 4) Hohmann & Barnard, Inc.; Quadro-Vent.
 - 5) Wire-Bond; Cell Vent.
- E. Cavity Drainage Material: Free-draining mesh, made from polymer strands that will not degrade within the wall cavity.
 - 1. Provide one of the following configurations:
 - a. Strips, full-depth of cavity and 10 inches wide, with dovetail shaped notches 7 inches deep that prevent mesh from being clogged with mortar droppings.
 - 2. Products:
 - a. Mortar Net USA, Ltd.; Mortar Net.
 - b. CAV Clear.
 - c. Mortar Halt.

2.12 CAVITY-WALL INSULATION

- A. Extruded-Polystyrene Board Insulation: ASTM C 578, Type IV, closed-cell product extruded with an integral skin.
- B. Adhesive: Type recommended by insulation board manufacturer for application indicated.

2.13 MASONRY CLEANERS

- A. Proprietary Acidic Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry without discoloring or damaging masonry surfaces. Use product expressly approved for intended use by cleaner manufacturer and manufacturer of masonry units being cleaned.
 - 1. Manufacturers:
 - a. Diedrich Technologies, Inc.
 - b. EaCo Chem, Inc.
 - c. ProSoCo, Inc.

2.14 MORTAR AND GROUT MIXES

- A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures, unless otherwise indicated.
 - 1. Do not use calcium chloride in mortar or grout.
 - 2. Limit cementitious materials in mortar to portland cement, mortar cement, and lime.
- B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.
- C. Mortar for Unit Masonry: Comply with ASTM C 270, Proportion Specification. Provide the following types of mortar for applications stated unless another type is indicated or needed to provide required compressive strength of masonry.
 - 1. For masonry below grade or in contact with earth, use Type S.
 - 2. For reinforced masonry, use Type S.
- D. Pigmented Mortar: Use colored cement product.
 - 1. Pigments shall not exceed 10 percent of portland cement by weight.
 - 2. Pigments shall not exceed 5 percent of masonry cement or mortar cement by weight.
 - 3. Mix to match Design Professional's sample.
- E. Colored-Aggregate Mortar: Produce required mortar color by using colored aggregates and natural color or white cement as necessary to produce required mortar color.
 - 1. Mix to match Design Professional's sample.
- F. Grout for Unit Masonry: Comply with ASTM C 476.
 - 1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with Table 1.15.1 in ACI 530.1/ASCE 6/TMS 602 for dimensions of grout spaces and pour height.

2. Provide grout with a slump of 8 to 10 inches as measured according to ASTM C 143/C 143M.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.
 1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of work.
 2. Verify that foundations are within tolerances specified.
 3. Verify that reinforcing dowels are properly placed.
- B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping connections.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. Thickness: Build cavity and composite walls and other masonry construction to full thickness shown. Build single-wythe walls to actual widths of masonry units, using units of widths indicated.
- B. Build chases and recesses to accommodate items specified in this and other Sections.
- C. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match the construction immediately adjacent to opening.
- D. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.
- E. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures.
 1. Mix units from several pallets or cubes as they are placed.
- F. Wetting of Brick: Wet brick before laying if initial rate of absorption exceeds 30 g/30 sq. in. per minute when tested per ASTM C 67. Allow units to absorb water so they are damp but not wet at time of laying.
- G. Comply with construction tolerances in ACI 530.1/ASCE 6/TMS 602 and with the following:

1. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.
2. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 feet, or 1/2 inch maximum.
3. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.
4. For exposed bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch, with a maximum thickness limited to 1/2 inch. Do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch.
5. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch. Do not vary from adjacent bed-joint and head-joint thicknesses by more than 1/8 inch.
6. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than 1/16 inch except due to warpage of masonry units within tolerances specified for warpage of units.
7. For exposed bed joints and head joints of stacked bond, do not vary from a straight line by more than 1/16 inch from one masonry unit to the next.

3.3 LAYING MASONRY WALLS

- A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.
- B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond; do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.
- C. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than 4-inches. Bond and interlock each course of each wythe at corners. Do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.
- D. Stopping and Resuming Work: Stop work by racking back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar, remove loose masonry units and mortar, and wet brick if required before laying fresh masonry.
- E. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.
- F. Fill space between steel frames and masonry solidly with mortar, unless otherwise indicated.
- G. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below and rod mortar or grout into core.
- H. Fill cores in hollow concrete masonry units with grout 24 inches under bearing plates, beams, lintels, posts, and similar items, unless otherwise indicated.

- I. Build non-load-bearing interior partitions full height of story to underside of solid floor or roof structure above, unless otherwise indicated. Brace non-load bearing partitions per the drawings.
 1. Install compressible filler in joint between top of partition and underside of structure above.
 2. Fasten partition top anchors to structure above and build into top of partition. Grout cells of CMUs solidly around plastic tubes of anchors and push tubes down into grout to provide 1/2-inch clearance between end of anchor rod and end of tube. Space anchors 48 inches o.c., unless otherwise indicated.
 3. Wedge non-load-bearing partitions against structure above with small pieces of tile, slate, or metal. Fill joint with mortar after dead-load deflection of structure above approaches final position.
 4. At fire-rated partitions, treat joint between top of partition and underside of structure above to comply with Division 7 Section "Fire-Resistive Joint Systems."

3.4 MORTAR BEDDING AND JOINTING

- A. Lay hollow brick and concrete masonry units as follows:
 1. With face shells fully bedded in mortar and with head joints of depth equal to bed joints.
 2. With webs fully bedded in mortar in all courses of piers, columns, and pilasters.
 3. With webs fully bedded in mortar in grouted masonry, including starting course on footings.
 4. With entire units, including areas under cells, fully bedded in mortar at starting course on footings where cells are not grouted.
- B. Lay solid masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.
- C. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness, unless otherwise indicated.

3.5 CAVITY WALLS

- A. Bond wythes of cavity walls together using one of the following methods:
 1. Individual Metal Ties: Provide ties as shown installed in horizontal joints, but not less than one metal tie for 2.67 sq. ft. of wall area spaced not to exceed 24 inches o.c. horizontally and 16 inches o.c. vertically. Stagger ties in alternate courses. Provide additional ties within 12 inches of openings and space not more than 36 inches apart around perimeter of openings. At intersecting and abutting walls, provide ties at no more than 24 inches o.c. vertically.
 - a. Where bed joints of wythes do not align, use adjustable (two-piece) type ties.
 - b. Where one wythe is of clay masonry and the other of concrete masonry, use adjustable (two-piece) type ties to allow for differential movement regardless of whether bed joints align.
 2. Masonry Joint Reinforcement: Installed in horizontal mortar joints.

- a. Where one wythe is of clay masonry and the other of concrete masonry, use adjustable (two-piece) type reinforcement with continuous horizontal wire in facing wythe attached to ties to allow for differential movement regardless of whether bed joints align.
3. Masonry Veneer Anchors: Comply with requirements for anchoring masonry veneers.
- B. Keep cavities clean of mortar droppings and other materials during construction. Bevel beds away from cavity, to minimize mortar protrusions into cavity. Do not attempt to trowel or remove mortar fins protruding into cavity.
- C. Coat cavity face of backup wythe to comply with Division 7 Section "Bituminous Dampproofing."
- D. Installing Cavity-Wall Insulation: Place small dabs of adhesive, spaced approximately 12 inches o.c. both ways, on inside face of insulation boards, or attach with plastic fasteners designed for this purpose. Fit courses of insulation between wall ties and other confining obstructions in cavity, with edges butted tightly both ways. Press units firmly against inside wythe of masonry or other construction as shown.
 1. Fill cracks and open gaps in insulation with crack sealer compatible with insulation and masonry.

3.6 MASONRY JOINT REINFORCEMENT

- A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch on exterior side of walls, 1/2 inch elsewhere. Lap reinforcement a minimum of 6 inches.
 1. Space reinforcement not more than 16 inches o.c.
- B. Interrupt joint reinforcement at control and expansion joints, unless otherwise indicated.
- C. Provide continuity at wall intersections by using prefabricated T-shaped units.
- D. Provide continuity at corners by using prefabricated L-shaped units.
- E. Cut and bend reinforcing units as directed by manufacturer for continuity at corners, returns, offsets, column fireproofing, pipe enclosures, and other special conditions.

3.7 ANCHORING MASONRY VENEERS

- A. Anchor masonry veneers to wall framing and concrete and masonry backup with seismic masonry-veneer anchors to comply with the following requirements:
 1. Fasten screw-attached and seismic anchors through sheathing to wall framing and to concrete and masonry backup with metal fasteners of type indicated. Use two fasteners unless anchor design only uses one fastener.
 2. Embed connector sections and continuous wire in masonry joints. Provide not less than 2 inches of air space between back of masonry veneer and face of sheathing.

3. Locate anchor sections to allow maximum vertical differential movement of ties up and down.
4. Space anchors as indicated, but not more than 16 inches o.c. vertically and 32 inches o.c. horizontally with not less than 1 anchor for each 2.67 sq. ft. of wall area. Install additional anchors within 12 inches of openings and at intervals, not exceeding 36 inches, around perimeter.

3.8 CONTROL AND EXPANSION JOINTS

- A. General: Install control and expansion joint materials in unit masonry as masonry progresses. Do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement.
- B. Form control joints in concrete masonry as follows:
 1. Install preformed control-joint gaskets designed to fit standard sash block.
- C. Form expansion joints in brick made from clay or shale as follows:
 1. Build in compressible joint fillers where indicated.
 2. Form open joint full depth of brick wythe and of width indicated, but not less than 3/8 inch for installation of sealant and backer rod specified in Division 7 Section "Joint Sealants."

3.9 LINTELS

- A. Install steel lintels where indicated.
- B. Provide concrete or masonry lintels where shown and where openings of more than 12 inches for brick-size units and 24 inches for block-size units are shown without structural steel or other supporting lintels.
- C. Provide minimum bearing of 8 inches at each jamb, unless otherwise indicated.

3.10 FLASHING, WEEP HOLES, CAVITY DRAINAGE, AND VENTS

- A. General: Install embedded flashing and weep holes in masonry at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated. Install vents at shelf angles, ledges, and other obstructions to upward flow of air in cavities, and where indicated.
- B. Install flashing as follows, unless otherwise indicated:
 1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing with adhesive, sealant, or tape as recommended by flashing manufacturer.
 2. At masonry-veneer walls, extend flashing through veneer, across air space behind veneer, and up face of sheathing at least 8 inches; with upper edge tucked under building paper or building wrap, lapping at least 4 inches.

3. At lintels and shelf angles, extend flashing a minimum of 6 inches into masonry at each end. At heads and sills, extend flashing 6 inches at ends and turn up not less than 2 inches to form end dams.
 4. Install metal flashing termination beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch back from outside face of wall and adhere flexible flashing to top of metal flashing termination.
 5. Cut flexible flashing off flush with face of wall after masonry wall construction is completed.
- C. Install reglets and nailers for flashing and other related construction where they are shown to be built into masonry.
- D. Install weep holes in head joints in exterior wythes of first course of masonry immediately above embedded flashing and as follows:
1. Use specified weep/vent products to form weep holes.
 2. Use wicking material to form weep holes above flashing under brick sills. Turn wicking down at lip of sill to be as inconspicuous as possible.
 3. Space weep holes 24 inches o.c., unless otherwise indicated.
 4. Cover cavity side of weep holes with plastic insect screening at cavities insulated with loose-fill insulation.
 5. Trim wicking material flush with outside face of wall after mortar has set.
- E. Place cavity drainage material in cavities to comply with configuration requirements for cavity drainage material in Part 2 "Miscellaneous Masonry Accessories" Article.
- F. Install vents in head joints in exterior wythes at spacing indicated. Use specified weep/vent products to form vents.
1. Close cavities off vertically and horizontally with blocking in manner indicated. Install through-wall flashing and weep holes above horizontal blocking.

3.11 REINFORCED UNIT MASONRY INSTALLATION

- A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.
1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
 2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other temporary loads that may be placed on them during construction.
- B. Placing Reinforcement: Comply with requirements in ACI 530.1/ASCE 6/TMS 602.
- C. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.

1. Comply with requirements in ACI 530.1/ASCE 6/TMS 602 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
2. Limit height of vertical grout pours to not more than 60 inches.

3.12 REPAIRING, POINTING, AND CLEANING

- A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.
- B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.
- C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.
- D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:
 1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
 2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Design Professional's approval of sample cleaning before proceeding with cleaning of masonry.
 3. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
 4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
 5. Clean brick by bucket-and-brush hand-cleaning method described in BIA Technical Notes 20.
 6. Clean masonry with a proprietary acidic cleaner applied according to manufacturer's written instructions.
 7. Clean concrete masonry by cleaning method indicated in NCMA TEK 8-2A applicable to type of stain on exposed surfaces.

3.13 MASONRY WASTE DISPOSAL

- A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project site.

END OF SECTION 042000

SECTION 055213 - PIPE AND TUBE RAILINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Steel pipe and tube railings.
- B. Related Sections include the following:
 - 1. Division 5 Section "Ornamental Railings" for ornamental railings fabricated from pipes and tubes.
 - 2. Division 6 Section "Rough Carpentry" for wood blocking for anchoring railings.
 - 3. Division 9 Section "Gypsum Board Assemblies" for metal backing for anchoring railings.

1.3 PERFORMANCE REQUIREMENTS

- A. General: In engineering railings to withstand structural loads indicated, determine allowable design working stresses of railing materials based on the following:
 - 1. Steel: 72 percent of minimum yield strength.
- B. Structural Performance: Provide railings capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
 - 1. Handrails:
 - a. Uniform load of 50 lbf/ applied in any direction.
 - b. Concentrated load of 200 lbf applied in any direction.
 - c. Uniform and concentrated loads need not be assumed to act concurrently.
 - 2. Top Rails of Guards:
 - a. Uniform load of 50 lbf/ ft.applied in any direction.
 - b. Concentrated load of 200 lbf applied in any direction.
 - c. Uniform and concentrated loads need not be assumed to act concurrently.
 - 3. Infill of Guards:
 - a. Concentrated load of 50 lbf applied horizontally on an area of 1 sq. ft.
 - b. Uniform load of 25 lbf/sq. ft. applied horizontally.

- c. Infill load and other loads need not be assumed to act concurrently.
 - C. Thermal Movements: Provide exterior railings that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 - 1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.
 - D. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.
- 1.4 SUBMITTALS
- A. Product Data: For the following:
 - 1. Manufacturer's product lines of mechanically connected railings.
 - 2. Grout, anchoring cement, and paint products.
 - B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - C. Samples for Initial Selection: For products involving selection of color, texture, or design, including mechanical finishes on stainless steel.
 - D. Samples for Verification: For each type of exposed finish required.
 - 1. Sections of each distinctly different linear railing member, including handrails, top rails, posts, and balusters.
 - 2. Fittings and brackets.
 - 3. Assembled Sample of railing system, made from full-size components, including top rail, post, handrail, and infill. Sample need not be full height.
 - a. Show method of finishing and connecting members at intersections.
 - E. Mill Certificates: Signed by manufacturers of stainless-steel products certifying that products furnished comply with requirements.
 - F. Welding certificates.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain each type of railing through one source from a single manufacturer.
- B. Welding: Qualify procedures and personnel according to the following:

1. AWS D1.1, "Structural Welding Code--Steel."

1.6 PROJECT CONDITIONS

- A. Field Measurements: Verify actual locations of walls and other construction contiguous with railings by field measurements before fabrication and indicate measurements on Shop Drawings.
 1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating railings without field measurements. Coordinate wall and other contiguous construction to ensure that actual dimensions correspond to established dimensions.
 2. Provide allowance for trimming and fitting at site.

1.7 COORDINATION AND SCHEDULING

- A. Coordinate installation of anchorages for railings. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.
- B. Schedule installation so wall attachments are made only to completed walls. Do not support railings temporarily by any means that do not satisfy structural performance requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Steel Pipe and Tube Railings:
 - a. Pisor Industries, Inc.
 - b. Sharpe Products.
 - c. Wagner, R & B, Inc.; a division of the Wagner Companies.

2.2 METALS, GENERAL

- A. Metal Surfaces, General: Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.
- B. Brackets, Flanges, and Anchors: Cast or formed metal of same type of material and finish as supported rails, unless otherwise indicated.

2.3 STEEL AND IRON

- A. Recycled Content of Steel Products: Provide products with an average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.
- B. Tubing: ASTM A 500 (cold formed).
- C. Pipe: ASTM A 53/A 53M, Type F or Type S, Grade A, Standard Weight (Schedule 40), unless another grade and weight are required by structural loads.
 - 1. Provide galvanized finish for exterior installations and where indicated.
- D. Plates, Shapes, and Bars: ASTM A 36/A 36M.
- E. Castings: Either gray or malleable iron, unless otherwise indicated.
 - 1. Gray Iron: ASTM A 48/A 48M, Class 30, unless another class is indicated or required by structural loads.
- F. Expanded Metal: ASTM F 1267, Type I (expanded), Class 1 (uncoated).

2.4 FASTENERS

- A. General: Provide the following:
 - 1. Steel Railings: Plated steel fasteners complying with ASTM B 633, Class Fe/Zn 25 for electrodeposited zinc coating.
- B. Fasteners for Anchoring Railings to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings to other types of construction indicated and capable of withstanding design loads.
- C. Fasteners for Interconnecting Railing Components:
 - 1. Provide concealed fasteners for interconnecting railing components and for attaching them to other work, unless otherwise indicated.
- D. Anchors: Provide cast-in-place anchors, fabricated from corrosion-resistant materials with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and equal to four times the load imposed when installed in concrete, as determined by testing per ASTM E 488 conducted by a qualified independent testing agency.

2.5 MISCELLANEOUS MATERIALS

- A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
- B. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79.

1. Use primer with a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 2. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.
- C. Shop Primer for Galvanized Steel: Zinc-dust, zinc-oxide primer formulated for priming zinc-coated steel and for compatibility with finish paint systems indicated, and complying with SSPC-Paint 5.
- D. Galvanizing Repair Paint: High-zinc-dust-content paint for regalvanizing welds in steel, complying with SSPC-Paint 20.
- E. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.
- F. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.
- G. Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound.
1. Water-Resistant Product: At exterior locations and where indicated provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended by manufacturer for exterior use.

2.6 FABRICATION

- A. General: Fabricate railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage, but not less than that required to support structural loads.
- B. Assemble railings in the shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.
- C. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch, unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- D. Form work true to line and level with accurate angles and surfaces.
- E. Fabricate connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.
- F. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items.
- G. Connections: Fabricate railings with welded connections, unless otherwise indicated.

- H. Welded Connections: Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove flux immediately.
 - 4. At exposed connections, finish exposed surfaces smooth and blended so no roughness shows after finishing and welded surface matches contours of adjoining surfaces.
- I. Form simple and compound curves by bending members in jigs to produce uniform curvature for each repetitive configuration required; maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.
- J. Close exposed ends of railing members with prefabricated end fittings.
- K. Provide wall returns at ends of wall-mounted handrails, unless otherwise indicated. Close ends of returns unless clearance between end of rail and wall is 1/4 inch or less.
- L. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect railing members to other work, unless otherwise indicated.
 - 1. At brackets and fittings fastened to plaster or gypsum board partitions, provide fillers made from crush-resistant material, or other means to transfer wall loads through wall finishes to structural supports and prevent bracket or fitting rotation and crushing of substrate.
- M. Provide inserts and other anchorage devices for connecting railings to concrete or masonry work. Fabricate anchorage devices capable of withstanding loads imposed by railings. Coordinate anchorage devices with supporting structure.
- N. For railing posts set in concrete, provide steel sleeves not less than 6 inches long with inside dimensions not less than 1/2 inch greater than outside dimensions of post, with steel plate forming bottom closure.
- O. Toe Boards: Where indicated, provide toe boards at railings around openings and at edge of open-sided floors and platforms. Fabricate to dimensions and details indicated.

2.7 FINISHES, GENERAL

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

- D. Provide exposed fasteners with finish matching appearance, including color and texture, of railings.

2.8 STEEL AND IRON FINISHES

- A. Galvanized Railings:
 - 1. Comply with ASTM A 123/A 123M for hot-dip galvanized railings.
- B. Fill vent and drain holes that will be exposed in the finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.
- C. For galvanized railings, provide hot-dip galvanized fittings, brackets, fasteners, sleeves, and other ferrous components.
- D. For nongalvanized steel railings, provide nongalvanized ferrous-metal fittings, brackets, fasteners, and sleeves, except galvanize anchors to be embedded in exterior concrete or masonry.
- E. Preparation for Shop Priming: After galvanizing, thoroughly clean railings of grease, dirt, oil, flux, and other foreign matter, and treat with metallic-phosphate process.
- F. Apply shop primer to prepared surfaces of railings, unless otherwise indicated. Comply with requirements in SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting. Primer need not be applied to surfaces to be embedded in concrete or masonry.
 - 1. Do not apply primer to galvanized surfaces.
 - 2. Stripe paint corners, crevices, bolts, welds, and sharp edges.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine plaster and gypsum board assemblies, where reinforced to receive anchors, to verify that locations of concealed reinforcements have been clearly marked for Installer. Locate reinforcements and mark locations if not already done.

3.2 INSTALLATION, GENERAL

- A. Fit exposed connections together to form tight, hairline joints.
- B. Perform cutting, drilling, and fitting required for installing railings. Set railings accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.

1. Do not weld, cut, or abrade surfaces of railing components that have been coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.
 2. Set posts plumb within a tolerance of 1/16 inch in 3 feet.
 3. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed 1/4 inch in 12 feet.
- C. Corrosion Protection: Coat concealed surfaces of aluminum that will be in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.
- D. Adjust railings before anchoring to ensure matching alignment at abutting joints.
- E. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing railings and for properly transferring loads to in-place construction.

3.3 RAILING CONNECTIONS

- A. Welded Connections: Use fully welded joints for permanently connecting railing components. Comply with requirements for welded connections in Part 2 "Fabrication" Article whether welding is performed in the shop or in the field.
- B. Expansion Joints: Install expansion joints at locations indicated but not farther apart than required to accommodate thermal movement. Provide slip-joint internal sleeve extending 2 inches beyond joint on either side, fasten internal sleeve securely to 1 side, and locate joint within 6 inches of post.

3.4 ANCHORING POSTS

- A. Use steel pipe sleeves preset and anchored into concrete for installing posts. After posts have been inserted into sleeves, fill annular space between post and sleeve with nonshrink, nonmetallic grout or anchoring cement, mixed and placed to comply with anchoring material manufacturer's written instructions.
- B. Form or core-drill holes not less than 5 inches deep and 3/4 inch larger than OD of post for installing posts in concrete. Clean holes of loose material, insert posts, and fill annular space between post and concrete with nonshrink, nonmetallic grout or anchoring cement, mixed and placed to comply with anchoring material manufacturer's written instructions.
- C. Cover anchorage joint with flange of same metal as post, welded to post after placing anchoring material.
- D. Anchor posts to metal surfaces with oval flanges, angle type, or floor type as required by conditions, connected to posts and to metal supporting members as follows:
1. For steel pipe railings, weld flanges to post and bolt to metal supporting surfaces.

3.5 ANCHORING RAILING ENDS

- A. Anchor railing ends to concrete and masonry with round flanges connected to railing ends and anchored to wall construction with anchors and bolts.
- B. Anchor railing ends to metal surfaces with flanges bolted to metal surfaces and welded to railing ends.

3.6 ATTACHING HANDRAILS TO WALLS

- A. Attach handrails to wall with wall brackets. Provide brackets with 1-1/2-inch clearance from inside face of handrail and finished wall surface.
 - 1. Use type of bracket with flange tapped for concealed anchorage to threaded hanger bolt.
- B. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.
- C. Secure wall brackets to building construction as follows:
 - 1. For concrete and solid masonry anchorage, use drilled-in expansion shields and hanger or lag bolts.
 - 2. For hollow masonry anchorage, use toggle bolts.
 - 3. For wood stud partitions, use hanger or lag bolts set into wood backing between studs. Coordinate with carpentry work to locate backing members.
 - 4. For steel-framed gypsum board partitions, fasten brackets directly to steel framing or concealed steel reinforcements using self-tapping screws of size and type required to support structural loads.

3.7 ADJUSTING AND CLEANING

- A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
- B. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Division 9 painting Sections.
- C. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

3.8 PROTECTION

- A. Protect finishes of railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at time of Substantial Completion.

- B. Restore finishes damaged during installation and construction period so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit, or provide new units.

END OF SECTION 055213

SECTION 061000 - ROUGH CARPENTRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Rooftop equipment bases and support curbs.
 - 2. Wood blocking, cants, and nailers.
 - 3. Plywood backing panels.

1.3 DEFINITIONS

- A. Exposed Framing: Framing not concealed by other construction.
- B. Dimension Lumber: Lumber of 2 inches nominal or greater but less than 5 inches nominal in least dimension.
- C. Timber: Lumber of 5 inches nominal or greater in least dimension.
- D. Lumber grading agencies, and the abbreviations used to reference them, include the following:
 - 1. NeLMA: Northeastern Lumber Manufacturers' Association.
 - 2. NLGA: National Lumber Grades Authority.
 - 3. RIS: Redwood Inspection Service.
 - 4. SPIB: The Southern Pine Inspection Bureau.
 - 5. WCLIB: West Coast Lumber Inspection Bureau.
 - 6. WWPA: Western Wood Products Association.

1.4 SUBMITTALS

- A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.
 - 1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.
 - 2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include physical properties of treated materials based on testing by a qualified independent testing agency.

3. For fire-retardant treatments specified to be High-Temperature (HT) type, include physical properties of treated lumber both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D 5664.
 4. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.
 5. Include copies of warranties from chemical treatment manufacturers for each type of treatment.
- B. Material Certificates: For dimension lumber specified to comply with minimum allowable unit stresses. Indicate species and grade selected for each use and design values approved by the ALSC Board of Review.
- C. Research/Evaluation Reports: For the following, showing compliance with building code in effect for Project:
1. Wood-preservative-treated wood.
 2. Fire-retardant-treated wood.
 3. Expansion anchors.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Stack lumber flat with spacers between each bundle to provide air circulation. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.1 WOOD PRODUCTS, GENERAL

- A. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.
1. Factory mark each piece of lumber with grade stamp of grading agency.
 2. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry lumber.
 3. Provide dressed lumber, S4S, unless otherwise indicated.

2.2 WOOD-PRESERVATIVE-TREATED LUMBER

- A. Preservative Treatment by Pressure Process: AWPAC2.

1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.
- B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or does not comply with requirements for untreated material.
- C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.
- D. Application: Treat rough carpentry as indicated below:
 1. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
 2. Wood sills, sleepers, blocking, furring, stripping, and similar concealed members in contact with masonry or concrete.
 3. Wood framing and furring attached directly to the interior of below-grade exterior masonry or concrete walls.
 4. Wood framing members that are less than (18 inches) above the ground in crawlspaces or unexcavated areas.
 5. Wood floor plates that are installed over concrete slabs-on-grade.

2.3 FIRE-RETARDANT-TREATED MATERIALS

- A. General: Comply with performance requirements in AWWA C20 (lumber) and AWWA C27 (plywood).
 1. Use Exterior type for exterior locations and where indicated.
 2. Use Interior Type A, unless otherwise indicated.
- B. Identify fire-retardant-treated wood with appropriate classification marking of testing and inspecting agency acceptable to authorities having jurisdiction.
- C. Application: Treat all rough carpentry unless noted otherwise.

2.4 MISCELLANEOUS LUMBER

- A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:
 1. Blocking.
 2. Nailers.
 3. Rooftop equipment bases and support curbs.
 4. Cants.
 5. Grounds.
- B. For items of dimension lumber size, provide Construction or No. 2 grade lumber with 19 percent maximum moisture content and any of the following species:
 1. Mixed southern pine; SPIB.

2. Spruce-pine-fir (south); NeLMA, WCLIB, or WWPA.
- C. For exposed boards, provide lumber with 19 percent maximum moisture content and any of the following species and grades:
1. Mixed southern pine, No. 1 grade; SPIB.
 2. Spruce-pine-fir (south) or spruce-pine-fir, Select Merchantable or No. 1 Common grade; NeLMA, NLGA, WCLIB, or WWPA.
- D. For concealed boards, provide lumber with 19 percent maximum moisture content and any of the following species and grades:
1. Mixed southern pine, No. 2 grade; SPIB.
 2. Spruce-pine-fir (south) or spruce-pine-fir, Construction or 2 Common grade; NeLMA, NLGA, WCLIB, or WWPA.
- E. For blocking not used for attachment of other construction, Utility, Stud, or No. 3 grade lumber of any species may be used provided that it is cut and selected to eliminate defects that will interfere with its attachment and purpose.
- F. For blocking and nailers used for attachment of other construction, select and cut lumber to eliminate knots and other defects that will interfere with attachment of other work.

2.5 PLYWOOD BACKING PANELS

- A. Telephone and Electrical Equipment Backing Panels: DOC PS 1, Exposure 1, C-D Plugged, fire-retardant treated, in thickness indicated or, if not indicated, not less than (1/2-inch) nominal thickness.

2.6 FASTENERS

- A. General: Provide fasteners of size and type indicated that comply with requirements specified in this Article for material and manufacture.
1. Where rough carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M.
- B. Nails, Brads, and Staples: ASTM F 1667.
- C. Power-Driven Fasteners: NES NER-272.
- D. Wood Screws: ASME B18.6.1.
- E. Lag Bolts: (ASME B18.2.1).
- F. Bolts: Steel bolts complying with (ASTM A 307, Grade A); with (ASTM A 563) hex nuts and, where indicated, flat washers.

- G. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to 6 times the load imposed when installed in unit masonry assemblies and equal to 4 times the load imposed when installed in concrete as determined by testing per ASTM E 488 conducted by a qualified independent testing and inspecting agency.
 - 1. Material: Carbon-steel components, zinc plated to comply with ASTM B 633, Class Fe/Zn 5.

2.7 MISCELLANEOUS MATERIALS

- A. Sill-Sealer Gaskets: Closed-cell neoprene foam, (1/4 inch) thick, selected from manufacturer's standard widths to suit width of sill members indicated.
- B. Adhesives for Gluing Furring and Sleepers to Concrete or Masonry: Formulation complying with ASTM D 3498 that is approved for use indicated by adhesive manufacturer.
 - 1. Use adhesives that have a VOC content of 70 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. Water-Repellent Preservative: NWWDA-tested and -accepted formulation containing 3-iodo-2-propynyl butyl carbamate, combined with an insecticide containing chlorpyrifos as its active ingredient.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Set rough carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit rough carpentry to other construction; scribe and cope as needed for accurate fit. Locate furring, nailers, blocking, grounds, and similar supports to comply with requirements for attaching other construction.
- B. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.
 - 1. Provide metal clips for fastening gypsum board or lath at corners and intersections where framing or blocking does not provide a surface for fastening edges of panels. Space clips not more than (16 inches) o.c.
- C. Provide fire blocking in furred spaces, stud spaces, and other concealed cavities as indicated and as required to maintain specified UL fire rating.:
- D. Sort and select lumber so that natural characteristics will not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.

- E. Comply with AWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.
 - 1. Use inorganic boron for items that are continuously protected from liquid water.
 - 2. Use copper naphthenate for items not continuously protected from liquid water.
- F. Securely attach rough carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
 - 1. NES NER-272 for power-driven fasteners.
 - 2. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code.
 - 3. Table 2306.1, "Fastening Schedule," in SBCCI's Standard Building Code.
- G. Use common wire nails, unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood; do not countersink nail heads, unless otherwise indicated.
- H. For exposed work, arrange fasteners in straight rows parallel with edges of members, with fasteners evenly spaced, and with adjacent rows staggered.
 - 1. Use finishing nails, unless otherwise indicated. Countersink nail heads and fill holes with wood filler.

3.2 WOOD GROUND, SLEEPER, BLOCKING, AND NAILER INSTALLATION

- A. Install where indicated and where required for screeding or attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.
- B. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces, unless otherwise indicated.
- C. Provide permanent grounds of dressed, pressure-preservative-treated, key-beveled lumber not less than (1-1/2 inches) wide and of thickness required to bring face of ground to exact thickness of finish material. Remove temporary grounds when no longer required.

3.3 PROTECTION

- A. Protect wood that has been treated with inorganic boron (SBX) from weather. If, despite protection, inorganic boron-treated wood becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.
- B. Protect rough carpentry from weather. If, despite protection, rough carpentry becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION 061000

SECTION 064116 - INTERIOR ARCHITECTURAL WOODWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Plastic-laminate cabinets.
 - 2. Solid surface material countertops.
- B. Related Sections include the following:
 - 1. Division 6 Section "Rough Carpentry" for wood furring, blocking, shims, and hanging strips required for installing woodwork and concealed within other construction before woodwork installation.
 - 2. Division 09 Section "Non-Structural Metal Framing" for reinforcements in metal-framed partitions for casework.
 - 3. Division 09 Section "Resilient Base and Accessories" for resilient base applied to casework.

1.3 DEFINITIONS

- A. Interior architectural woodwork includes wood furring, blocking, shims, and hanging strips for installing woodwork items unless concealed within other construction before woodwork installation.

1.4 SUBMITTALS

- A. Product Data: For panel products high-pressure decorative laminate adhesive for bonding plastic laminate solid-surfacing material, cabinet hardware and accessories and finishing materials and processes.
- B. Shop Drawings: Show location of each item, dimensioned plans and elevations, large-scale details, attachment devices, and other components.
 - 1. Show details full size.
 - 2. Show locations and sizes of furring, blocking, and hanging strips, including concealed blocking and reinforcement specified in other Sections.
 - 3. Show locations and sizes of cutouts and holes for plumbing fixtures faucets soap dispensers and other items installed in architectural woodwork.

4. Show veneer leaves with dimensions, grain direction, exposed face, and identification numbers indicating the flitch and sequence within the flitch for each leaf.
5. Apply WI-certified compliance label to first page of Shop Drawings.

C. Samples for Initial Selection:

1. Plastic laminates.
2. PVC edge material.
3. Thermoset decorative panels.
4. Solid-surfacing materials.

D. Samples for Verification:

1. Plastic laminates, 8 by 10 inches, for each type, color, pattern, and surface finish, with 1 sample applied to core material and specified edge material applied to 1 edge.
2. Thermoset decorative-panels, 8 by 10 inches, for each type, color, pattern, and surface finish, with edge banding on 1 edge.
3. Exposed cabinet hardware and accessories, one unit for each type and finish.
4. Solid surface material, 6" square.

E. Product Certificates: For each type of product, signed by product manufacturer.

F. Woodwork Quality Standard Compliance Certificates: AWI Quality Certification Program certificates.

G. Qualification Data: For Installer and fabricator.

1.5 QUALITY ASSURANCE

A. Fabricator Qualifications: Shop that employs skilled workers who custom-fabricate products similar to those required for this Project and whose products have a record of successful in-service performance. Shop is a certified participant in AWI's Quality Certification Program.

B. Installer Qualifications: Certified participant in AWI's Quality Certification Program.

C. Source Limitations: Engage a qualified woodworking firm to assume undivided responsibility for production of interior architectural woodwork with sequence-matched wood veneers.

D. Quality Standard: Unless otherwise indicated, comply with AWI's "Architectural Woodwork Quality Standards" for grades of interior architectural woodwork indicated for construction, finishes, installation, and other requirements.

1. Provide AWI Quality Certification Program labels and certificates indicating that woodwork, including installation, complies with requirements of grades specified.

E. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

- F. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Do not deliver woodwork until painting and similar operations that could damage woodwork have been completed in installation areas. If woodwork must be stored in other than installation areas, store only in areas where environmental conditions comply with requirements specified in "Project Conditions" Article.

1.7 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install woodwork until building is enclosed, wet work is complete, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.
- B. Field Measurements: Where woodwork is indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication, and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
 - 1. Locate concealed framing, blocking, and reinforcements that support woodwork by field measurements before being enclosed, and indicate measurements on Shop Drawings.
 - 2. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating woodwork without field measurements. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

1.8 COORDINATION

- A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to ensure that interior architectural woodwork can be supported and installed as indicated.

PART 2 - PRODUCTS

2.1 WOODWORK FABRICATORS

- A. Fabricators: Subject to compliance with requirements, provide interior architectural woodwork by one of the following:

2.2 MATERIALS

- A. General: Provide materials that comply with requirements of AWI's quality standard for each type of woodwork and quality grade specified, unless otherwise indicated.

- B. Wood Products: Comply with the following:
1. Hardboard: AHA A135.4.
 2. Medium-Density Fiberboard: ANSI A208.2, Grade MD, made with binder containing no urea formaldehyde.
 3. Particleboard: ANSI A208.1, Grade M-2-Exterior Glue.
 4. Softwood Plywood: DOC PS 1, Medium Density Overlay.
- C. Thermoset Decorative Panels: Particleboard or medium-density fiberboard finished with thermally fused, melamine-impregnated decorative paper complying with LMA SAT-1.
1. Provide PVC or polyester edge banding complying with LMA EDG-1 on components with exposed or semiexposed edges.
- D. High-Pressure Decorative Laminate: NEMA LD 3, grades as indicated or, if not indicated, as required by woodwork quality standard.
1. Manufacturer: Subject to compliance with requirements, provide high-pressure decorative laminates by one of the following:
 - a. Abet Laminati, Inc.
 - b. Arborite; Division of ITW Canada, Inc.
 - c. Formica Corporation.
 - d. Lamin-Art, Inc.
 - e. Nevamar Company, LLC; Decorative Products Div.
 - f. Panolam Industries International Incorporated.
 - g. Westinghouse Electric Corp.; Specialty Products Div.
 - h. Wilsonart International; Div. of Premark International, Inc.
- E. Solid-Surfacing Material: Homogeneous solid sheets of filled plastic resin complying with ISSFA-2.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ABA Industries.
 - b. Avonite, Inc.
 - c. E. I. du Pont de Nemours and Company.
 - d. Formica Corporation.
 - e. LG Chemical, Ltd.
 - f. Meganite Inc.; a division of the Pyrochem Group.
 - g. Nevamar Company, LLC; Decorative Products Div.
 - h. Samsung; Cheil Industries Inc.
 - i. Swan Corporation (The).
 - j. Transolid, Inc.
 - k. Wilsonart International; Div. of Premark International, Inc.
 2. Type: Standard type.
 3. Colors and Patterns: As indicated in drawings.
 4. Thickness: 2cm deck with 4cm edge.

2.3 CABINET HARDWARE AND ACCESSORIES

- A. General: Provide cabinet hardware and accessory materials associated with architectural cabinets.
- B. Butt Hinges: Stainless-steel, semi-concealed, 5-knuckle hinges complying with BHMA A156.9, Grade 1, with antifriction bearings and rounded tips. Provide 2 hinges for doors less than 48 inches high and 3 hinges for doors more than 48 inches high.
- C. Wire Pulls: Back mounted, solid metal, 4 inches long, 5/16 inch in diameter.
- D. Catches: Magnetic catches, BHMA A156.9, B03141.
- E. Adjustable Shelf Standards and Supports: BHMA A156.9, B04071; with shelf rests, B04081.
- F. Drawer Slides: BHMA A156.9, B05091.
 - 1. Heavy Duty (Grade 1HD-100 and Grade 1HD-200): Side mounted; full-extension type; zinc-plated steel ball-bearing slides.
 - 2. Box Drawer Slides: Grade 1 HD-100; for drawers not more than 6 inches high and 24 inches wide.
 - 3. File Drawer Slides: Grade 1HD-100; for drawers more than 6 inches high or 24 inches wide.
 - 4. Pencil Drawer Slides: Grade 1; for drawers not more than 3 inches high and 24 inches wide.
 - 5. Keyboard Slides: Grade 1HD-100; for computer keyboard shelves.
 - 6. Trash Bin Slides: Grade 1HD-100; for trash bins not more than 20 inches high and 16 inches wide.
- G. Door Locks: BHMA A156.11, E07121. Provide locks on all doors.
- H. Drawer Locks: BHMA A156.11, E07041. Provide locks on all drawers.
- I. Grommets for Cable Passage through Countertops: 2-inch Insert size OD, black, molded-plastic grommets and matching plastic caps with slot for wire passage.
- J. Exposed Hardware Finishes: For exposed hardware, provide finish that complies with BHMA A156.18 for BHMA finish number indicated.
 - 1. Satin Stainless Steel: BHMA 630.
- K. For concealed hardware, provide manufacturer's standard finish that complies with product class requirements in BHMA A156.9.

2.4 MISCELLANEOUS MATERIALS

- A. Furring, Blocking, Shims, and Hanging Strips: Softwood or hardwood lumber, kiln dried to less than 15 percent moisture content.

- B. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide nonferrous-metal or hot-dip galvanized anchors and inserts on inside face of exterior walls and elsewhere as required for corrosion resistance. Provide toothed-steel or lead expansion sleeves for drilled-in-place anchors.
- C. Adhesives, General: Do not use adhesives that contain urea formaldehyde.
- D. VOC Limits for Installation Adhesives and Glues: Use installation adhesives that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
 - 1. Wood Glues: 30 g/L.
 - 2. Contact Adhesive: 250 g/L.
- E. Adhesive for Bonding Plastic Laminate: Unpigmented contact cement.

2.5 FABRICATION, GENERAL

- A. Interior Woodwork Grade: Unless otherwise indicated, provide Premium-grade interior woodwork complying with referenced quality standard.
- B. Wood Moisture Content: Comply with requirements of referenced quality standard for wood moisture content in relation to ambient relative humidity during fabrication and in installation areas.
- C. Fabricate woodwork to dimensions, profiles, and details indicated. Ease edges to radius indicated for the following:
 - 1. Corners of Cabinets and Edges of Solid-Wood (Lumber) Members 3/4 inch thick or Less: 1/16 inch.
 - 2. Edges of Rails and Similar Members More Than 3/4 inch thick: 1/8 inch.
 - 3. Corners of Cabinets and Edges of Solid-Wood (Lumber) Members and Rails: 1/16 inch.
- D. Complete fabrication, including assembly, finishing, and hardware application, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.
 - 1. Notify Design Professional seven days in advance of the dates and times woodwork fabrication will be complete.
 - 2. Trial fit assemblies at fabrication shop that cannot be shipped completely assembled. Install dowels, screws, bolted connectors, and other fastening devices that can be removed after trial fitting. Verify that various parts fit as intended and check measurements of assemblies against field measurements indicated on Shop Drawings before disassembling for shipment.
- E. Shop-cut openings to maximum extent possible to receive hardware, appliances, plumbing fixtures, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.

1. Seal edges of openings in countertops with a coat of varnish.

2.6 PLASTIC-LAMINATE CABINETS

- A. Grade: Premium.
- B. AWI Type of Cabinet Construction: Reveal overlay.
- C. Laminate Cladding for Exposed Surfaces: High-pressure decorative laminate complying with the following requirements:
 1. Horizontal Surfaces Other Than Tops: Grade HGS.
 2. Postformed Surfaces: Grade HGP.
 3. Vertical Surfaces: Grade VGS.
 4. Edges: PVC edge banding, 0.12 inch thick, matching laminate in color, pattern, and finish.
- D. Materials for Semiexposed Surfaces:
 1. Surfaces Other Than Drawer Bodies: Thermoset decorative panels.
 - a. Edges of Plastic-Laminate Shelves: PVC edge banding, 0.12 inch thick, matching laminate in color, pattern, and finish.
 - b. For semiexposed backs of panels with exposed plastic-laminate surfaces, provide surface of high-pressure decorative laminate, Grade VGS.
 2. Drawer Sides and Backs: Thermoset decorative panels.
 3. Drawer Bottoms: Thermoset decorative panels.
- E. Concealed Backs of Panels with Exposed Plastic Laminate Surfaces: High-pressure decorative laminate, Grade BKL.
- F. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces complying with the following requirements:
 1. Match Design Professional's sample.
- G. Provide dust panels of 1/4-inch plywood or tempered hardboard above compartments and drawers, unless located directly under tops.

2.7 SOLID-SURFACING-MATERIAL COUNTERTOPS

- A. Grade: Premium.
- B. Solid-Surfacing-Material Thickness: 2cm.
- C. Colors, Patterns, and Finishes: Provide materials and products that result in colors of solid-surfacing material complying with the following requirements:
- D. Fabricate tops in one piece, unless otherwise indicated. Comply with solid-surfacing-material manufacturer's written recommendations for adhesives, sealers, fabrication, and finishing.

1. Fabricate tops with shop-applied edges of materials and configuration indicated.
 2. Fabricate tops with shop-applied backsplashes.
- E. Install integral sink bowls in countertops in shop.
- F. Drill holes in countertops for plumbing fittings and soap dispensers in shop.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Before installation, condition woodwork to average prevailing humidity conditions in installation areas.
- B. Before installing architectural woodwork, examine shop-fabricated work for completion and complete work as required, including removal of packing and backpriming.

3.2 INSTALLATION

- A. Grade: Install woodwork to comply with requirements for the same grade specified in Part 2 for fabrication of type of woodwork involved.
- B. Assemble woodwork and complete fabrication at Project site to comply with requirements for fabrication in Part 2, to extent that it was not completed in the shop.
- C. Install woodwork level, plumb, true, and straight. Shim as required with concealed shims. Install level and plumb (including tops) to a tolerance of 1/8 inch in 96 inches.
- D. Scribe and cut woodwork to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.
- E. Anchor woodwork to anchors or blocking built in or directly attached to substrates. Secure with countersunk, concealed fasteners and blind nailing as required for complete installation.
- F. Cabinets: Install without distortion so doors and drawers fit openings properly and are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation. Complete installation of hardware and accessory items as indicated.
1. Install cabinets with no more than 1/8 inch in 96-inch sag, bow, or other variation from a straight line.
 2. Maintain veneer sequence matching of cabinets with transparent finish.
 3. Fasten wall cabinets through back, near top and bottom, at ends and not more than 16 inches o.c. with No. 10 wafer-head screws sized for 1-inch penetration into wood framing, blocking, or hanging strips.
- G. Countertops: Anchor securely by screwing through corner blocks of base cabinets or other supports into underside of countertop.

1. Align adjacent solid-surfacing-material countertops and form seams to comply with manufacturer's written recommendations using adhesive in color to match countertop. Carefully dress joints smooth, remove surface scratches, and clean entire surface.
2. Install countertops with no more than 1/8 inch in 96-inch sag, bow, or other variation from a straight line.
3. Secure backsplashes to tops with concealed metal brackets at 16 inches o.c. and to walls with adhesive.
4. Calk space between backsplash and wall with sealant specified in Division 7 Section "Joint Sealants."

3.3 ADJUSTING AND CLEANING

- A. Repair damaged and defective woodwork, where possible, to eliminate functional and visual defects; where not possible to repair, replace woodwork. Adjust joinery for uniform appearance.
- B. Clean, lubricate, and adjust hardware.
- C. Clean woodwork on exposed and semiexposed surfaces. Touch up shop-applied finishes to restore damaged or soiled areas.

END OF SECTION 064116

SECTION 071113 - BITUMINOUS DAMPPROOFING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Cold-applied, asphalt emulsion dampproofing.

1.2 SUBMITTALS

- A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.
- B. Product data for each type of product specified, including data substantiating that materials comply with requirements for each dampproofing material specified. Include recommended method of application, recommended primer, number of coats, coverage or thickness, and recommended protection course.

1.3 PROJECT CONDITIONS

- A. Substrate: Proceed with dampproofing only after substrate construction and penetrating work have been completed.
- B. Weather Limitations: Proceed with dampproofing only when existing and forecasted weather conditions will permit work to be performed according to manufacturer's recommendations and warranty requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cold-Applied, Asphalt Emulsion Dampproofing:
 - a. ChemRex, Inc.; Sonneborn Building Products Div.
 - b. Euclid Chemical Co.
 - c. Karnak Chemical Corporation.
 - d. Koppers Industries, Inc.
 - e. Meadows: W.R. Meadows, Inc.
 - f. Gardner Gibson

2.2 BITUMINOUS DAMPPROOFING

- A. General: Provide products recommended by manufacturer for designated application.

- B. Cold-Applied, Asphalt Emulsion Dampproofing: Asphalt-based emulsions recommended by the manufacturer for dampproofing use when applied according to the manufacturer's instructions.
 - 1. Spray Grade: Emulsified asphalt, prepared with mineral-colloid emulsifying agents without fibrous reinforcement, complying with ASTM D 1227, Type II.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean substrate of projections and substances detrimental to work; comply with recommendations of prime materials manufacturer.
- B. Protection of Other Work: Do not allow liquid and mastic compounds to enter and clog drains and conductors. Prevent spillage and migration onto other surfaces of work by masking or otherwise protecting adjoining work.

3.2 INSTALLATION, GENERAL

- A. Comply with manufacturer's recommendations except where more stringent requirements are indicated and where Project conditions require extra precautions to ensure satisfactory performance of work.
- B. Application: Apply dampproofing to the following surfaces.
 - 1. Exterior, below-grade surfaces of exterior concrete or masonry walls in contact with earth or other backfill and where space is enclosed on opposite side.
 - 2. Exterior surface of inside wythe of double-wythe, exterior masonry walls above grade, to prevent water-vapor penetration through the wall.
 - 3. Where indicated on the Drawings.
- C. Apply vertical dampproofing down walls from finished-grade line to top of footing, extend over top of footing, and down a minimum of 6 inches over outside face of footing. Extend 12 inches onto intersecting walls and footings, but do not extend onto surfaces exposed to view when the Project is completed.

3.3 COLD-APPLIED, ASPHALT EMULSION DAMPPROOFING

- A. Spray Grade: Brush or spray apply a coat of asphalt emulsion dampproofing at a rate of 1.5 to 2.5 gal./100 sq. ft., depending on substrate texture, to produce a uniform, dry-film thickness of not less than 15 mils. Apply in 2 coats, if necessary, to obtain required thickness, allowing time for complete drying between coats.

3.4 PROTECTION AND CLEANING

- A. Protect exterior, below-grade dampproofing membrane from damage until backfill is completed. Remove overspray and spilled materials from surfaces not intended to receive dampproofing.

3.5 INSTALLATION OF PROTECTION COURSE

- A. General: Where indicated, install protection course of type indicated over completed-and-cured dampproofing treatment. Comply with dampproofing materials manufacturer's recommendations for method of support or attaching of protection materials. Support with spot application of trowel-grade mastic where not otherwise indicated.

END OF SECTION 071113

SECTION 071353 - ELASTOMERIC SHEET WATERPROOFING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Rubberized asphalt sheet waterproofing.

1.3 PERFORMANCE REQUIREMENTS

- A. Provide waterproofing that prevents the passage of water.

1.4 SUBMITTALS

- A. Product Data: Include manufacturer's written instructions for evaluating, preparing, and treating substrate, technical data, and tested physical and performance properties of waterproofing.
- B. Shop Drawings: Show locations and extent of waterproofing. Include details for substrate joints and cracks, sheet flashings, penetrations, inside and outside corners, tie-ins with adjoining waterproofing, and other termination conditions.
 - 1. Include Setting Drawings showing layout, sizes, sections, profiles, and joint details of concrete pavers with paver support assemblies.
- C. Samples: For the following products:
 - 1. 12-by-12-inch square of waterproofing.
 - 2. 4-by-4-inch square of drainage panel.
- D. Installer Certificates: Signed by manufacturers certifying that installers comply with requirements.
- E. Product Test Reports: From a qualified independent testing agency indicating and interpreting test results of waterproofing for compliance with requirements, based on comprehensive testing of current waterproofing formulations.
- F. Sample Warranty: Copy of waterproofing manufacturer's and Installer's warranty stating obligations, remedies, limitations, and exclusions before starting waterproofing.

1.5 QUALITY ASSURANCE

- A. **Installer Qualifications:** A qualified installer who is authorized, approved, or licensed by waterproofing manufacturer to install manufacturer's products; and who is eligible to receive waterproofing warranty specified.
- B. **Source Limitations:** Obtain waterproofing materials, protection course, through one source from a single manufacturer.
- C. **Mockups:** Apply waterproofing to 100 sq. ft of wall to demonstrate surface preparation, crack and joint treatment, corner treatment, and execution quality.
 - 1. Mockup must be inspected and approved by manufacturer representative.
 - 2. Approved mockups may become part of the completed work.
- D. **Preinstallation Conference:** Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination." Review requirements for waterproofing, including surface preparation specified under other Sections, substrate condition and pretreatment, minimum curing period, forecasted weather conditions, special details and sheet flashings, installation procedures, testing and inspection procedures, and protection and repairs, Substrate must be inspected and approved by installer prior to beginning installation.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver liquid materials to Project site in original packages with seals unbroken, labeled with manufacturer's name, product brand name and type, date of manufacture, and directions for storing and mixing with other components.
- B. Store liquid materials in their original undamaged packages in a clean, dry, protected location and within temperature range required by waterproofing manufacturer.
- C. Remove and replace liquid materials that cannot be applied within their stated shelf life.
- D. Store rolls according to manufacturer's written instructions.
- E. Protect stored materials from direct sunlight.

1.7 PROJECT CONDITIONS

- A. **Environmental Limitations:** Apply waterproofing within range of ambient and substrate temperatures recommended by waterproofing manufacturer. Do not apply waterproofing to a damp or wet substrate.
 - 1. Do not apply waterproofing in snow, rain, fog, or mist.
- B. Maintain adequate ventilation during preparation and application of waterproofing materials.

1.8 WARRANTY

- A. Special Manufacturer's Warranty: Written warranty, signed by waterproofing manufacturer agreeing to replace waterproofing material that does not comply with requirements or that does not remain watertight within specified warranty period.
 - 1. Warranty Period: 10 years after date of Substantial Completion.
- B. Special Installer's Warranty: Written waterproofing Installer's warranty, signed by Installer, covering Work of this Section, for warranty period of two years.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide one of the following products:
 - 1. Rubberized Asphalt Sheet:
 - a. Bituthene 3000 by Grace.
 - 2. Other Manufacturers:
 - a. Firestone
 - b. Tremco

2.2 SHEET WATERPROOFING

- A. Rubberized Asphalt Sheet: A self-adhesive, cold-applied composite sheet consisting of a thickness of 1.4 mm (0.056 in.) of rubberized asphalt and 0.1mm (0.004 in.) of cross-laminated, high density polyethylene film. Provide rubberized asphalt membrane covered with a release sheet which is removed during installation.

2.3 AUXILIARY MATERIALS

- A. General: Furnish auxiliary materials recommended by waterproofing manufacturer for intended use and compatible with sheet waterproofing.
 - 1. Furnish liquid-type auxiliary materials that comply with VOC limits of authorities having jurisdiction.
- B. Concealed Sheet Flashing: Same material, construction, and thickness as sheet waterproofing or 60-mil- thick, as required by manufacturer.
- C. Bonding Adhesives: Adhesive for bonding polymeric sheets and sheet flashings to substrates and projections.

- D. Splicing Cement and Cleaner: Single-component butyl splicing cement and solvent-based splice cleaner.
 - 1. Butyl Gum Tape: 30-mil-thick-by-6-1/4-inch-wide, uncured butyl with polyethylene release film.
- E. Lap Sealant: Single-component sealant.
- F. In-Seam Sealant: Single-component sealant.
- G. Water Cutoff Mastic: Butyl mastic sealant.
- H. Waterproofing and Sheet Flashing Accessories: Provide sealants, pourable sealers, cone and vent flashings, inside and outside corner flashings, termination reglets, and other accessories recommended by waterproofing manufacturer for intended use.
- I. Metal Termination Bars: Manufacturer's standard aluminum bars, approximately 1 inch (25 mm) wide, prepunched, with zinc-alloy-body fasteners and stainless-steel pins.

2.4 MOLDED-SHEET DRAINAGE PANELS

- A. Nonwoven-Geotextile-Faced, Molded-Sheet Drainage Panel: Hydroduct 220 and Hydroduct 660 by Grace.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance.
 - 1. Do not proceed with installation until after the minimum concrete curing period recommended by waterproofing manufacturer.
 - 2. Verify that substrate is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D 4263.
 - 3. Notify Design Professional in writing of anticipated problems using waterproofing over substrate.
 - 4. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SURFACE PREPARATION

- A. Clean, prepare, and treat substrate according to manufacturer's written instructions. Provide clean, dust-free, and dry substrate for waterproofing application.
- B. Mask off adjoining surfaces not receiving waterproofing to prevent spillage and overspray affecting other construction.

- C. Remove grease, oil, bitumen, form-release agents, paints, curing compounds, and other penetrating contaminants or film-forming coatings from concrete.
- D. Remove fins, ridges, mortar, and other projections and fill honeycomb, aggregate pockets, holes, and other voids.
- E. Prepare, fill, prime, and treat joints and cracks in substrate. Remove dust and dirt from joints and cracks according to ASTM D 4258.
- F. Prepare, treat, and seal vertical and horizontal surfaces at terminations and penetrations through waterproofing and at drains and protrusions.

3.3 FULLY ADHERED SHEET INSTALLATION

- A. Install fully adhered sheets over entire area to receive waterproofing according to manufacturer's written instructions and recommendations in ASTM D 5843.
- B. Accurately align sheets and maintain uniform side and end laps of minimum dimensions required. Stagger end laps.
- C. Apply bonding adhesive to substrates at required rate and allow to partially dry.
- D. Apply bonding adhesive to sheets and firmly adhere sheets to substrates. Do not apply bonding adhesive to splice area of sheet.
- E. Install fully adhered sheets and auxiliary materials to tie into existing waterproofing.
- F. Repair tears, voids, and lapped seams in waterproofing not complying with requirements. Slit and flatten fishmouths and blisters. Patch with sheet waterproofing extending beyond repaired areas in all directions.
- G. Horizontal Application: Apply sheets with side laps shingled with slope of deck where possible.
 - 1. Spread sealant or mastic bed over deck drain flange at deck drains and securely seal sheet waterproofing in place with clamping ring.

3.4 SEAM INSTALLATION

- A. Cement and Tape Splice: Clean splice areas, apply splicing cement and butyl gum tape, and firmly roll side and end laps of overlapping sheets according to manufacturer's written instructions to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of sheet terminations.

3.5 SHEET FLASHING INSTALLATION

- A. Install sheet flashings and preformed flashing accessories and adhere to substrates according to waterproofing manufacturer's written instructions.

- B. Form wall flashings using exposed sheet flashing.
- C. Extend deck sheet waterproofing to form wall flashings.
 - 1. Flash penetrations and field-formed inside and outside corners with uncured sheet flashing.
 - 2. Clean splice areas, apply splicing cement, and firmly roll side and end laps of overlapping sheets to ensure a watertight installation. Apply lap sealant and seal exposed edges of sheet flashing terminations.
- D. Cover expansion joints and discontinuous deck-to-wall or deck-to-deck joints by extending deck sheet waterproofing over joints.
- E. Terminate and seal top of sheet flashings with mechanically anchored termination bars.

3.6 MOLDED-SHEET DRAINAGE PANEL INSTALLATION

- A. Place and secure molded-sheet drainage panels according to manufacturer's written instructions. Use adhesives or mechanical fasteners that do not penetrate waterproofing. Lap edges and ends of geotextile to maintain continuity. Protect installed molded-sheet drainage panels during subsequent construction.

3.7 FIELD QUALITY CONTROL

- A. Prior to covering completed installation, the completed work must be inspected and approved by manufacturer's representative.

3.8 PROTECTION AND CLEANING

- A. Do not permit foot or vehicular traffic on unprotected membrane.
- B. Protect waterproofing from damage and wear during remainder of construction period.
- C. Protect installed insulation drainage panels from damage due to ultraviolet light, harmful weather exposures, physical abuse, and other causes. Provide temporary coverings where insulation will be subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.
- D. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 071353

SECTION 072100 - THERMAL INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Spray polyurethane foam insulation.
- B. Related Sections:
 - 1. Section 078446 "Fire-Resistive Joint Systems" for insulation installed as part of a perimeter fire-resistive joint system.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

1.4 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each product.

1.5 QUALITY ASSURANCE

- A. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Protect insulation materials from physical damage and from deterioration due to moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.

PART 2 - PRODUCTS

2.1 SPRAY POLYURETHANE FOAM INSULATION

- A. Open-Cell Polyurethane Foam Insulation: Spray-applied polyurethane foam using water as a blowing agent, with maximum flame-spread and smoke developed indexes of 75 and 450, respectively, per ASTM E 84.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. BaySystems NorthAmerica, LLC.
 - b. BASF corporation.
 - c. Dow Chemical Company (The).
 - d. Gaco Western Inc.
 - e. Icynene Inc.
 - f. SWD Urethane Company.
 - g. Icynene, Inc.
 - 2. Minimum density of 0.4 lb/cu. ft., thermal resistivity of 3.4 deg F x h x sq. ft./Btu x in. at 75 deg F.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean substrates of substances that are harmful to insulation or that interfere with insulation attachment.

3.2 INSTALLATION, GENERAL

- A. Comply with insulation manufacturer's written instructions applicable to products and applications indicated.
- B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.
- C. Extend insulation to envelop entire area to be insulated. Cut and fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.
- D. Provide sizes to fit applications indicated and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units to produce thickness indicated unless multiple layers are otherwise shown or required to make up total thickness.

3.3 INSTALLATION OF INSULATION FOR FRAMED CONSTRUCTION

- A. Apply insulation units to substrates by method indicated, complying with manufacturer's written instructions. If no specific method is indicated, bond units to substrate with adhesive or use mechanical anchorage to provide permanent placement and support of units.
- B. Spray-Applied Insulation: Apply spray-applied insulation according to manufacturer's written instructions. Do not apply insulation until installation of pipes, ducts, conduits, wiring, and electrical outlets in walls is completed and windows, electrical boxes, and other items not indicated to receive insulation are masked. After insulation is applied, make flush with face of studs by using method recommended by insulation manufacturer.
- C. Miscellaneous Voids: Install insulation in miscellaneous voids and cavity spaces where required to prevent gaps in insulation using the following materials:
 - 1. Spray Polyurethane Insulation: Apply according to manufacturer's written instructions.

3.4 PROTECTION

- A. Protect installed insulation from damage due to harmful weather exposures, physical abuse, and other causes. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

END OF SECTION 072100

SECTION 074113 - METAL ROOF PANELS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:

1. Factory-formed and field-assembled, standing-seam metal roof panels.
2. Metal soffit panels.
3. Glass-mat gypsum insulation cover board.
4. Roof insulation.

- B. Related Sections include the following:

1. Division 05 Section "Steel Decking" for steel roof deck supporting metal roof panels.
2. Division 05 Section "Cold-Formed Metal Framing" for secondary support framing supporting metal roof panels.
3. Division 07 Section "Sheet Metal Flashing and Trim" for flashings and other sheet metal work not part of metal roof panel assemblies.

1.3 DEFINITIONS

- A. Metal Roof Panel Assembly: Metal roof panels, attachment system components, miscellaneous metal framing, thermal insulation, and accessories necessary for a complete weathertight roofing system.
- B. Solar Flux: Direct and diffuse radiation from the sun received at ground level over the solar spectrum, expressed in watts per square meter.
- C. Solar Reflectance: Fraction of solar flux reflected by a surface, expressed as a percent or within the range of 0.00 and 1.00.
- D. Steel Sheet Thickness: Minimum thickness of base metal without metallic coatings or painted finishes.

1.4 PERFORMANCE REQUIREMENTS

- A. General: Provide metal roof panel assemblies that comply with performance requirements specified as determined by testing manufacturers' standard assemblies similar to those indicated for this Project, by a qualified testing and inspecting agency.
- B. Air Infiltration: Air leakage through assembly of not more than 0.06 cfm/sq. ft. of roof area when tested according to ASTM E 1680 at the following test-pressure difference:
 - 1. Test-Pressure Difference: Positive and negative 1.57 lbf/sq. ft..
- C. Water Penetration: No water penetration when tested according to ASTM E 1646 at the following test-pressure difference:
 - 1. Positive Preload Test-Pressure Difference: Greater than or equal to 15.0 lbf/sq. ft. and the greater of 75 percent of building live load or 50 percent of building design positive wind-pressure difference.
- D. Water Absorption: Maximum 1.0 percent absorption rate by volume when tested according to ASTM C 209.
- E. Wind-Uplift Resistance: Provide metal roof panel assemblies that comply with UL 580 for wind-uplift resistance class indicated.
- F. Structural Performance: Provide metal roof panel assemblies capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated, based on testing according to ASTM E 1592:
 - 1. Wind Loads: Determine loads based on the following minimum design wind pressures:
 - a. Uniform pressure as indicated on Drawings.
 - 2. Deflection Limits: Engineer metal roof panel assemblies to withstand design loads with vertical deflections no greater than 1/240 of the span.
- G. Seismic Performance: Provide metal roof panel assemblies capable of withstanding the effects of earthquake motions determined according to ASCE 7, "Minimum Design Loads for Buildings and Other Structures: "Section 9, "Earthquake Loads."
- H. Thermal Movements: Provide metal roof panel assemblies that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 - 1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.
- I. Thermal Performance: Provide insulated metal roof panel assemblies with thermal-resistance value (R-value) indicated when tested according to ASTM C 236 or ASTM C 518, Energy Star Rated.
- J. Solar Reflectance for Roofs with Slopes of 2:12 or Less: Initial solar reflectance of not less than 0.65 when tested according to ASTM E 903, and maintained, under normal conditions, solar reflectance of not less than 0.50 for 3 years after installation.

- K. Solar Reflectance for Roofs with Slopes Steeper Than 2:12: Initial solar reflectance of not less than 0.25 when tested according to ASTM E 903, and maintained, under normal conditions, solar reflectance not less than 0.15 for 3 years after installation.

1.5 SUBMITTALS

- A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of metal roof panel and accessory.
- B. Shop Drawings: Show fabrication and installation layouts of metal roof panels; details of edge conditions, joints, panel profiles, corners, anchorages, trim, flashings, closures, and accessories; and special details. Distinguish between factory- and field-assembled work.
 - 1. Accessories: Include details of the following items, at a scale of not less than 1-1/2 inches per 12 inches:
 - a. Flashing and trim.
 - b. Fascia and soffit.
 - c. Gutters and downspouts.
 - 2. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- C. Coordination Drawings: Roof plans drawn to scale and coordinating penetrations and roof-mounted items. Show the following:
 - 1. Roof panels and attachments.
 - 2. Purlins and rafters.
 - 3. Roof-mounted items including roof hatches, equipment supports, pipe supports and penetrations, lighting fixtures, snow guards, and items mounted on roof curbs.
 - 4. Layout and thickness of insulation.
- D. Samples for Initial Selection: For each type of metal roof panel indicated with factory-applied color finishes.
 - 1. Include similar Samples of trim and accessories involving color selection.
 - 2. Roof insulation.
- E. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below.
 - 1. Metal Roof and Soffit Panels: 12 inches long by actual panel width. Include fasteners, clips, closures, and other metal roof panel accessories.
 - 2. Trim and Closures: 12 inches long. Include fasteners and other exposed accessories.
 - 3. Accessories: 12-inch- long Samples for each type of accessory.
- F. Qualification Data: For Installer.

- G. Field quality-control inspection reports. Provide 3 inspections by Manufacturer's representative; start-up, mid installation, and final inspection.
- H. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for the following:
 - 1. Metal Roof and Soffit Panels: Include reports for air infiltration, water penetration, thermal performance, fire-test-response characteristics, solar reflectance, and structural performance.
- I. Maintenance Data: For metal roof panels to include in maintenance manuals.
- J. Warranties: Special warranties specified in this Section.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An employer of workers trained and approved by manufacturer.
 - 1. Installer's responsibilities include fabricating and installing metal roof panel assemblies and providing professional engineering services needed to assume engineering responsibility.
 - 2. Engineering Responsibility: Preparation of data for metal roof panels, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.
 - 3. Installer must be certified by Panel Manufacturer as top tier authorized installer.
- B. Source Limitations: Obtain each type of metal roof panels through one source from a single manufacturer.
- C. Fire-Resistance Ratings: Where indicated, provide metal roof panels identical to those of assemblies tested for fire resistance per ASTM E 119 by a testing and inspecting agency acceptable to authorities having jurisdiction.
 - 1. Combustion Characteristics: ASTM E 136.
 - 2. Fire-Resistance Ratings: Indicated by design designations from UL's "Fire Resistance Directory" or from the listings of another testing and inspecting agency.
 - 3. Metal roof panels shall be identified with appropriate markings of applicable testing and inspecting agency.
- D. Surface-Burning Characteristics: Provide insulated metal roof panels having insulation core material with the following surface-burning characteristics as determined by testing identical products per ASTM E 84 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:
 - 1. Flame-Spread Index: 25 or less, unless otherwise indicated.
 - 2. Smoke-Developed Index: 450 or less, unless otherwise indicated.
- E. Mockups: Build mockups to verify selections made under sample Submittals and to demonstrate aesthetic effects and qualities of materials and execution.

1. Build mockup of typical roof eave, including fascia, and soffit as shown on Drawings; approximately 48 inches square by full thickness, including insulation, underlayment, attachments, and accessories.
 2. Approval of mockups is for other material and construction qualities specifically approved by Design Professional in writing.
 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless such deviations are specifically approved by Design Professional in writing.
 4. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
- F. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination." Review methods and procedures related to metal roof panel assemblies including, but not limited to, the following:
1. Meet with Owner, Design Professional, Owner's insurer if applicable, testing and inspecting agency representative, metal roof panel Installer, metal roof panel manufacturer's representative, deck Installer, and installers whose work interfaces with or affects metal roof panels including installers of roof accessories and roof-mounted equipment.
 2. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 3. Review methods and procedures related to metal roof panel installation, including manufacturer's written instructions.
 4. Examine deck substrate conditions for compliance with requirements, including flatness and attachment to structural members.
 5. Review structural loading limitations of deck purlins and rafters during and after roofing.
 6. Review flashings, special roof details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that will affect metal roof panels.
 7. Review governing regulations and requirements for insurance, certificates, and testing and inspecting if applicable.
 8. Review temporary protection requirements for metal roof panel assembly during and after installation.
 9. Review roof observation and repair procedures after metal roof panel installation.
 10. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver components, sheets, metal roof panels, and other manufactured items so as not to be damaged or deformed. Package metal roof panels for protection during transportation and handling.
- B. Unload, store, and erect metal roof panels in a manner to prevent bending, warping, twisting, and surface damage.
- C. Stack metal roof panels on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal roof panels to ensure dryness. Do not store metal roof panels in contact with other materials that might cause staining, denting, or other surface damage.

- D. Protect strippable protective covering on metal roof panels from exposure to sunlight and high humidity, except to extent necessary for period of metal roof panel installation.
- E. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.

1.8 PROJECT CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal roof panels to be performed according to manufacturers' written instructions and warranty requirements.
- B. Field Measurements: Verify locations of roof framing and roof opening dimensions by field measurements before metal roof panel fabrication and indicate measurements on Shop Drawings.
 - 1. Established Dimensions: Where field measurements cannot be made without delaying the Work, either establish framing and opening dimensions and proceed with fabricating metal roof panels without field measurements, or allow for field-trimming of panels. Coordinate roof construction to ensure that actual building dimensions, locations of structural members, and openings correspond to established dimensions.

1.9 COORDINATION

- A. Coordinate installation of roof curbs, equipment supports, and roof penetrations, which are specified in Division 07 Section "Roof Accessories."
- B. Coordinate metal panel roof assemblies with rain drainage work, flashing, trim, and construction of decks, parapets, walls, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.10 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal roof panel assemblies that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures, including rupturing, cracking, or puncturing.
 - b. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 - 2. Warranty Period: 5 years from date of Substantial Completion.

- B. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal roof panels that show evidence of deterioration of factory-applied finishes within specified warranty period.
 - 1. Fluoropolymer Finish: Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
 - b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 - 2. Finish Warranty Period: 20 years from date of Substantial Completion.
- C. Special Weathertightness Warranty for Standing-Seam Metal Roof Panels: Manufacturer's standard, no dollar limit, non-rated, edge to edge warranty in which manufacturer agrees to repair or replace standing-seam metal roof panel assemblies that fail to remain weathertight, including leaks, within specified warranty period.
 - 1. Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply for product selection:
 - 1. Products: Subject to compliance with requirements, provide one of the products specified.
 - 2. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 PANEL MATERIALS

- A. Metallic-Coated Steel Sheet Prepainted with Coil Coating: Steel sheet metallic coated by the hot-dip process and prepainted by the coil-coating process to comply with ASTM A 755/A 755M.
 - 1. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A 792/A 792M, Class AZ50 coating designation, Grade 50 KSI; structural quality.
 - 2. Surface: Smooth, with standard striations.
 - 3. Exposed Finishes: Apply the following coil coating, as specified or indicated on Drawings.
 - a. High-Performance Organic Finish: Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - 1) Fluoropolymer Two-Coat System: Manufacturer's standard two-coat, thermocured system consisting of specially formulated inhibitive primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight; complying with physical properties and coating performance requirements of AAMA 2604, except as modified below:

- a) Humidity Resistance: 2000 hours.
 - b) Salt-Spray Resistance: 2000 hours.
4. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil.

B. Panel Sealants:

1. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch wide and 1/8 inch thick.
2. Joint Sealant: ASTM C 920; elastomeric polyurethane or polysulfide; of type, grade, class, and use classifications required to seal joints in metal roof panels and remain weathertight; and as recommended in writing by metal roof panel manufacturer.
3. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C 1311.

2.3 UNDERLAYMENT MATERIALS

- A. Self-Adhering, High-Temperature Sheet: 45 to 60 mils thick minimum, consisting of slip-resisting polyethylene-film top surface laminated to layer of butyl or SBS-modified asphalt adhesive, with release-paper backing; cold applied. Provide primer when recommended by underlayment manufacturer.

1. Thermal Stability: Stable after testing at 240 deg F; ASTM D 1970.
2. Low Temperature Flexibility: Passes after testing at minus 20 deg F; ASTM D 1970.
3. Products:
 - a. Carlisle Coatings & Waterproofing, Div. of Carlisle Companies Inc.; Dri-Start "HR."
 - b. Grace, W. R. & Co.; Vycor Ultra.
 - c. Henry Company; Perma-Seal PE.
 - d. Metal-Fab Manufacturing, LLC; MetShield.
 - e. TC MiraDRI; WIP 300HT.

2.4 MISCELLANEOUS METAL FRAMING

- A. General: Comply with ASTM C 754 for conditions indicated.

1. Steel Sheet Components: Complying with ASTM C 645 requirements for metal and with ASTM A 653/A 653M, G40, hot-dip galvanized zinc coating.

- B. Hat-Shaped, Rigid Furring Channels: ASTM C 645.
 - 1. Minimum Base Metal Thickness: 0.0312 inch.
 - 2. Depth: 7/8 inch.
- C. Cold-Rolled Furring Channels: 0.0538-inch bare steel thickness, with minimum 1/2-inch- wide flange.
 - 1. Depth: 3/4 inch.
 - 2. Furring Brackets: Adjustable, corrugated-edge type of steel sheet with minimum bare steel thickness of 0.0312 inch.
 - 3. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.0625-inch- diameter wire, or double strand of 0.0475-inch- diameter wire.
- D. Z-Shaped Furring: With slotted or nonslotted web, face flange of 1-1/4 inches, wall attachment flange of 7/8 inch, minimum bare metal thickness of 0.0179 inch, and depth required to fit insulation thickness indicated.
- E. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.

2.5 MISCELLANEOUS MATERIALS

- A. Fasteners: Self-tapping screws, bolts, nuts, self-locking rivets and bolts, end-welded studs, and other suitable fasteners designed to withstand design loads. Provide exposed fasteners with heads matching color of metal roof panels by means of plastic caps or factory-applied coating.
 - 1. Fasteners for Roof Panels: Self-drilling or self-tapping, zinc-plated, hex-head carbon-steel screws, with a stainless-steel cap or zinc-aluminum-alloy head and EPDM or neoprene sealing washer. Exposed screws shall have a one piece cap.
 - 2. Fasteners for Flashing and Trim: Blind fasteners or self-drilling screws with hex washer head.
 - 3. Blind Fasteners: High-strength aluminum or stainless-steel rivets.
- B. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

2.6 STANDING-SEAM METAL ROOF PANELS

- A. General: Provide factory-formed metal roof panels designed to be field assembled by lapping and interconnecting raised side edges of adjacent panels with joint type indicated and mechanically attaching panels to supports using concealed clips in side laps. Include clips, cleats, pressure plates, and accessories required for weather-tight installation.
 - 1. Steel Panel Systems: Unless more stringent requirements are indicated, comply with ASTM E 1514.

- B. Vertical-Rib, Snap-Joint, Standing-Seam Metal Roof Panels: Formed with vertical ribs at panel edges and intermediate stiffening ribs symmetrically spaced between ribs; designed for sequential installation by mechanically attaching panels to supports using concealed clips located under one side of panels, engaging opposite edge of adjacent panels, and snapping panels together.

1. Manufacturers:

- a. AEP-Span.
- b. Architectural Building Components.
- c. Architectural Roofing and Siding, Inc.
- d. ATAS International, Inc.
- e. Berridge Manufacturing Company.
- f. BHP Steel Building Products USA Inc.
- g. CENTRIA Architectural Systems.
- h. Copper Sales Inc.
- i. Custom Panel Industries, LLC.
- j. Delcoa Industries, Inc.
- k. Fabral, Inc.
- l. Flexospan Steel Buildings, Inc.
- m. MBCI; Div. of NCI Building Systems.
- n. McElroy Metal, Inc.
- o. Merchant & Evans, Inc.
- p. Metal-Fab Manufacturing, LLC.
- q. Metal Sales Manufacturing Corporation.
- r. Modern Metal Systems, Inc.
- s. Morin Corporation; a Metecno Group Company.
- t. Steelox Systems Inc.
- u. United Steel Deck, Inc.; Subsidiary of Bouras Industries, Inc.

2. Material: Zinc-coated (galvanized) steel sheet, 24 ga.

3. Exterior Finish: Galvalume.

4. Clips: Floating to accommodate thermal movement.

a. Material: 0.0528-inch- thick, zinc-coated (galvanized) steel sheet.

5. Panel Coverage: 16 inches.

6. Panel Height: 1.5 inches.

7. Uplift Rating: UL 90.

2.7 METAL SOFFIT AND FASCIA PANELS

- A. General: Provide factory-formed metal fascia and soffit panels designed to be field assembled by lapping and interconnecting side edges of adjacent panels and mechanically attaching through panel to supports using concealed fasteners and factory-applied sealant in side laps. Include accessories required for weathertight installation.

- B. V-Groove-Profile Metal Soffit Panels: Solid (non-perforated) panels formed with vertical panel edges and intermediate stiffening ribs symmetrically spaced between panel edges; with V-groove joint between panels.
 - 1. Manufacturers:
 - a. AMS.
 - b. MBCI.
 - c. McElroy Metal.
 - 2. Material: Aluminum-zinc alloy-coated steel sheet, 0.0209 inch thick.
 - a. Exterior Finish: Fluoropolymer.
 - b. Color: Match Design Professional's samples.

2.8 ACCESSORIES

- A. Roof Panel Accessories: Provide components required for a complete metal roof panel assembly including trim, copings, fasciae, corner units, ridge closures, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal roof panels, unless otherwise indicated.
 - 1. Closures: Provide closures at eaves and ridges, fabricated of same metal as metal roof panels.
 - 2. Clips: Minimum 0.0625-inch- thick, stainless-steel panel clips designed to withstand negative-load requirements.
 - 3. Cleats: Mechanically seamed cleats formed from minimum 0.0250-inch- thick, stainless-steel or nylon-coated aluminum sheet.
 - 4. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
 - 5. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch- thick, flexible closure strips; cut or premolded to match metal roof panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.
- B. Flashing and Trim: Formed from 0.0179-inch- thick, aluminum-zinc alloy-coated steel sheet prepainted with coil coating. Provide flashing and trim as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, eaves, rakes, corners, bases, framed openings, ridges, fasciae, and fillers. Finish flashing and trim with same finish system as adjacent metal roof panels.
- C. Gutters: Formed from 0.0179-inch- thick, aluminum-zinc alloy-coated steel sheet prepainted with coil coating. Complete with end pieces, outlet tubes, and other special pieces as required. Fabricate in minimum 96-inch- long sections, sized according to SMACNA's "Architectural Sheet Metal Manual." Furnish gutter supports spaced 36 inches o.c., fabricated from same metal as gutters. Provide bronze, copper, or aluminum wire ball strainers at outlets. Finish gutters to match Design Professional's sample.

- D. Downspouts: Formed from 0.0179-inch- thick, aluminum-zinc alloy-coated steel sheet prepainted with coil coating; in 10-foot- long sections, complete with formed elbows and offsets. Finish downspouts to match Design Professional's sample.
- E. Roof Curbs: Fabricated from 0.0478-inch- thick, zinc-coated (galvanized) steel sheet or aluminum-zinc alloy-coated steel sheet prepainted with coil coating; with welded top box and bottom skirt, and integral full-length cricket. Fabricate curb subframing of minimum 0.0598-inch- thick, angle-, C-, or Z-shaped steel sheet. Fabricate curb and subframing to withstand indicated loads, of size and height indicated. Finish roof curbs to match metal roof panels.
 - 1. Insulate roof curb with 1-inch- thick, rigid insulation.
 - 2. Install curbs level.
 - 3. Install weather stripping between unit and curb.
- F. Pipe Flashing: Premolded, EPDM pipe collar with flexible aluminum ring bonded to base.

2.9 ROOF INSULATION

- A. General: Preformed roof insulation boards approved for use in FM Approvals' RoofNav listed roof assemblies.
- B. Polyisocyanurate Board Insulation: ASTM C1289, Type II, Class 1, Grade 2, felt or glass-fiber mat facer on both major surfaces.
 - 1. Manufacturers:
 - a. GAF
 - b. Kingspan
 - c. Owens-Corning
 - d. Siplast
 - e. Certainteed
 - f. Dow
 - 2. Compressive Strength: 24 psi.
 - 3. Size: 48 by 96 inches.
 - 4. Thickness:
 - a. Base Layer: 1-1/2 inches.
 - b. Upper Layer: as required to meet R-30.

2.10 INSULATION ACCESSORIES

- A. General: Roof insulation accessories recommended by insulation manufacturer for intended use and compatibility with other roofing system components.
- B. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roof insulation and cover boards to substrate, and acceptable to roofing system manufacturer.

- C. Insulation Adhesive: Insulation manufacturer's recommended adhesive formulated to attach roof insulation to substrate or to another insulation layer as follows:
 - 1. Modified asphaltic, asbestos-free, cold-applied adhesive.
 - 2. Bead-applied, low-rise, one-component or multicomponent urethane adhesive.
 - 3. Full-spread, spray-applied, low-rise, two-component urethane adhesive.

- D. Cover Board: ASTM C1177/C1177M, glass-mat, water-resistant gypsum board or ASTM C1278/C1278M fiber-reinforced gypsum board.
 - 1. Manufacturers:
 - a. Basis of Design; Dens-Deck Prime by Georgia-Pacific Corp.
 - b. USG
 - c. National Gypsum
 - 2. Thickness: 5/8 inch.
 - 3. Surface Finish: Factory primed.

2.11 FABRICATION

- A. General: Fabricate and finish metal roof panels and accessories at the factory to greatest extent possible, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.

- B. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.

- C. Where indicated, fabricate metal roof panel joints with factory-installed captive gaskets or separator strips that provide a tight seal and prevent metal-to-metal contact, in a manner that will minimize noise from movements within panel assembly.

- D. Sheet Metal Accessories: Fabricate flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to the design, dimensions, metal, and other characteristics of item indicated.
 - 1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
 - 2. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.
 - 3. Sealed Joints: Form nonexpansion but movable joints in metal to accommodate elastomeric sealant to comply with SMACNA standards.
 - 4. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
 - 5. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended by metal roof panel manufacturer.

- a. Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal roof panel manufacturer for application but not less than thickness of metal being secured.

2.12 FINISHES, GENERAL

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal roof panel supports, and other conditions affecting performance of work.
 - 1. Examine primary and secondary roof framing to verify that rafters, purlins, angles, channels, and other structural panel support members and anchorages have been installed within alignment tolerances required by metal roof panel manufacturer.
 - 2. Examine solid roof sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal roof panel manufacturer.
 - 3. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of work.
- B. Examine roughing-in for components and systems penetrating metal roof panels to verify actual locations of penetrations relative to seam locations of metal roof panels before metal roof panel installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean substrates of substances harmful to insulation, including removing projections capable of interfering with insulation attachment.

- B. Miscellaneous Framing: Install subpurlins, eave angles, furring, and other miscellaneous roof panel support members and anchorage according to metal roof panel manufacturer's written recommendations.
 - 1. Soffit Framing: Wire-tie or clip furring channels to supports, as required to comply with requirements for assemblies indicated.

3.3 UNDERLAYMENT INSTALLATION

- A. Self-Adhering Sheet Underlayment: Install self-adhering sheet underlayment, wrinkle free, on factory-primed gypsum board cover boards under metal roof panels. Apply primer if required by manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation; use primer rather than nails for installing underlayment at low temperatures. Apply over entire roof, in shingle fashion to shed water, with end laps of not less than 6 inches staggered 24 inches between courses. Overlap side edges not less than 3-1/2 inches. Roll laps with roller. Cover underlayment within 14 days.
- B. Install flashings to cover underlayment to comply with requirements specified in Division 07 Section "Sheet Metal Flashing and Trim."

3.4 METAL ROOF PANEL INSTALLATION, GENERAL

- A. General: Provide metal roof panels of full length from eave to ridge. Anchor metal roof panels and other components of the Work securely in place, with provisions for thermal and structural movement.
 - 1. Field cutting of metal roof panels by torch or saw is not permitted.
 - 2. Rigidly fasten panels at ridge. Cleat panels at eaves and valleys. Allow for movement due thermal expansion and contraction. Panels shall be panned at the ridge prior to installation of closures and ridge cap.
 - 3. Provide metal closures at peaks, rake edges, rake walls, and each side of ridge and hip caps.
 - 4. Flash and seal metal roof panels with weather closures at eaves, rakes, and at perimeter of all openings. Fasten with self-tapping screws.
 - 5. Locate and space fastenings in uniform vertical and horizontal alignment.
 - 6. Install ridge and hip caps as metal roof panel work proceeds.
 - 7. Panels shall be continuous from ridge to eave, no splices or lap joints.
 - 8. Lap metal flashing over metal roof panels to allow moisture to run over and off the material.
- B. Fasteners:
 - 1. Steel Roof Panels: Use stainless-steel fasteners for surfaces exposed to the exterior and galvanized steel fasteners for surfaces exposed to the interior.
- C. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating, by

applying rubberized-asphalt underlayment to each contact surface, or by other permanent separation as recommended by metal roof panel manufacturer.

- D. Joint Sealers: Install gaskets, joint fillers, and sealants where indicated and where required for weatherproof performance of metal roof panel assemblies. Provide types of gaskets, fillers, and sealants indicated or, if not indicated, types recommended by metal roof panel manufacturer.
 - 1. Seal metal roof panel end laps with double beads of tape or sealant, full width of panel. Seal side joints where recommended by metal roof panel manufacturer.
 - 2. Prepare joints and apply sealants to comply with requirements in Division 07 Section "Joint Sealants."
 - 3. Silicone sealants are not permitted.

3.5 FIELD-ASSEMBLED METAL ROOF PANEL INSTALLATION

- A. Standing-Seam Metal Roof Panels: Fasten metal roof panels to supports with concealed clips at each standing-seam joint at location, spacing, and with fasteners recommended by manufacturer.
 - 1. Install clips to supports with self-tapping fasteners.
 - 2. Install pressure plates at locations indicated in manufacturer's written installation instructions.
 - 3. Snap Joint: Nest standing seams and fasten together by interlocking and completely engaging factory-applied sealant.
- B. Metal Soffit Panels: Provide metal soffit panels full width of soffits. Install panels perpendicular to support framing.
 - 1. Flash and seal panels with weather closures where metal soffit panels meet walls and at perimeter of all openings.
- C. Fascia Panels: Align bottom of panels and fasten with blind rivets, bolts, or self-tapping screws. Flash and seal panels with weather closures where fasciae meet soffits, along lower panel edges, and at perimeter of all openings.

3.6 ACCESSORY INSTALLATION

- A. General: Install accessories with positive anchorage to building and weathertight mounting and provide for thermal expansion. Coordinate installation with flashings and other components.
 - 1. Install components required for a complete metal roof panel assembly including trim, copings, ridge closures, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.
- B. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.

1. Install exposed flashing and trim that is without excessive oil canning, buckling, and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to result in waterproof and weather-resistant performance.
 2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped or bayonet-type expansion provisions cannot be used or would not be sufficiently weather resistant and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with mastic sealant (concealed within joints).
- C. Gutters: Join sections with riveted and soldered or lapped and sealed joints. Attach gutters to eave with gutter hangers spaced not more than 4 feet o.c. using manufacturer's standard fasteners. Provide end closures and seal watertight with sealant. Provide joints for thermal expansion at 40°-0" max.
- D. Downspouts: Join sections with 1-1/2-inch telescoping joints. Provide fasteners designed to hold downspouts securely 1 inch away from walls; locate fasteners at top and bottom and at approximately 60 inches o.c. in between.
1. Provide elbows at base of downspouts to direct water away from building.
 2. Tie downspouts to underground drainage system indicated.
- E. Roof Curbs: Install curbs at locations indicated on Drawings. Install flashing around bases where they meet metal roof panels.
- F. Pipe Flashing: Form flashing around pipe penetration and metal roof panels. Fasten and seal to metal roof panels as recommended by manufacturer.

3.7 INSTALLATION OF INSULATION

- A. Coordinate installing roofing system components so insulation is not exposed to precipitation or left exposed at end of workday.
- B. Comply with roofing system and insulation manufacturer's written instructions for installing roof insulation.
- C. Installation Over Metal Decking:
1. Install base layer of insulation with joints staggered not less than 24 inches in adjacent rows and with long joints continuous at right angle to flutes of decking.
 - a. Locate end joints over crests of decking.
 - b. Where installing composite and noncomposite insulation in two or more layers, install noncomposite board insulation for bottom layer and intermediate layers, if applicable, and install composite board insulation for top layer.
 - c. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
 - d. Make joints between adjacent insulation boards not more than 1/4 inch in width.

- e. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus 24 inches.
 - 1) Trim insulation so that water flow is unrestricted.
 - f. Fill gaps exceeding 1/4 inch with insulation.
 - g. Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.
 - h. Mechanically attach base layer of insulation using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to metal decks.
 - 1) Fasten insulation according to requirements in FM Approvals' RoofNav for specified Windstorm Resistance Classification.
 - 2) Fasten insulation to resist specified uplift pressure at corners, perimeter, and field of roof.
2. Install upper layers of insulation with joints of each layer offset not less than 12 inches from previous layer of insulation.
- a. Staggered end joints within each layer not less than 24 inches in adjacent rows.
 - b. Install with long joints continuous and with end joints staggered not less than 12 inches in adjacent rows.
 - c. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
 - d. Make joints between adjacent insulation boards not more than 1/4 inch in width.
 - e. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus 24 inches.
 - f. Trim insulation so that water flow is unrestricted.
 - g. Fill gaps exceeding 1/4 inch with insulation.
 - h. Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.
 - i. Loosely lay each layer of insulation units over substrate.
 - j. Adhere each layer of insulation to substrate using adhesive according to FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification and FM Global Property Loss Prevention Data Sheet 1-29, as follows:
 - 1) Set each layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.

3.8 INSTALLATION OF COVER BOARDS

- A. Install cover boards over insulation with long joints in continuous straight lines with end joints staggered between rows. Offset joints of insulation below a minimum of 6 inches in each direction.
 - 1. Trim cover board neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
 - 2. At internal roof drains, conform to slope of drain sump.
 - a. Trim cover board so that water flow is unrestricted.

3. Cut and fit cover board tight to nailers, projections, and penetrations.
4. Adhere cover board to substrate using adhesive according to FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification and FM Global Property Loss Prevention Data Sheet 1-29, as follows:
 - a. Set cover board in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.

3.9 ERECTION TOLERANCES

- A. Installation Tolerances: Shim and align metal roof panel units within installed tolerance of 1/4 inch in 20 feet on slope and location lines as indicated and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

3.10 FIELD QUALITY CONTROL

- A. Testing Agency: Owner may engage a qualified independent testing and inspecting agency to perform inspections and prepare reports.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect completed metal roof panel installation, including accessories. Report results in writing. Provide minimum of 4 visits; 1) Pre-Installation meeting, 2) Beginning of installation, 3) midterm installation, 4) Final inspection.
- C. Remove and replace applications of metal roof panels where inspections indicate that they do not comply with specified requirements.
- D. Additional inspections, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.11 CLEANING AND PROTECTION

- A. Remove temporary protective coverings and strippable films, if any, as metal roof panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of metal roof panel installation, clean finished surfaces as recommended by metal roof panel manufacturer. Maintain in a clean condition during construction.
- B. Replace metal roof panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 074113

SECTION 076200 - SHEET METAL FLASHING AND TRIM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

- 1. Manufactured Products:

- a. Manufactured reglets and counterflashing.

- 2. Formed Products:

- a. Formed roof drainage sheet metal fabrications.
 - b. Formed low-slope roof sheet metal fabrications.
 - c. Formed equipment support flashing.

- B. Related Sections:

- 1. Division 6 Section "Rough Carpentry for wood nailers, curbs, and blocking.
 - 2. Division 7 Section "Metal Roof Panels" for sheet metal flashing and trim integral with metal roof panels.
 - 3. Division 7 Section "Roof Accessories" for set-on-type curbs, equipment supports, roof hatches, vents, and other manufactured roof accessory units.

1.3 PERFORMANCE REQUIREMENTS

- A. General: Sheet metal flashing and trim assemblies as indicated shall withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim shall not rattle, leak, or loosen, and shall remain watertight.

- B. Fabricate and install roof edge flashing and copings capable of resisting the following forces according to recommendations in FMG Loss Prevention Data Sheet 1-49:

- 1. Wind Zone 1: As indicated on drawings.
 - 2. Wind Zone 2: As indicated on drawings.
 - 3. Wind Zone 3: As indicated on drawings.
 - 4. All edge flashing and parapet copings must be ES-1 rated.

- C. Thermal Movements: Provide sheet metal flashing and trim that allows for thermal movements from ambient and surface temperature changes.

- 1. Temperature Change (Range): 120 deg F, ambient material surfaces.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each manufactured product and accessory.

- B. Shop Drawings: Show fabrication and installation layouts of sheet metal flashing and trim, including plans, elevations, expansion-joint locations, and keyed details. Distinguish between shop- and field-assembled work. Include the following:

- 1. Identification of material, thickness, weight, and finish for each item and location in Project.
 - 2. Details for forming sheet metal flashing and trim, including profiles, shapes, seams, and dimensions.
 - 3. Details for joining, supporting, and securing sheet metal flashing and trim, including layout of fasteners, cleats, clips, and other attachments. Include pattern of seams.
 - 4. Details of termination points and assemblies, including fixed points.
 - 5. Details of expansion joints and expansion-joint covers, including showing direction of expansion and contraction.
 - 6. Details of edge conditions, including eaves, ridges, valleys, rakes, crickets, and counterflashings as applicable.
 - 7. Details of special conditions.
 - 8. Details of connections to adjoining work.
 - 9. Detail formed flashing and trim at a scale of not less than 1-1/2 inches per 12 inches.

- C. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below:

- 1. Sheet Metal Flashing: 12 inches long by actual width of unit, including finished seam and in required profile. Include fasteners, cleats, clips, closures, and other attachments.
 - 2. Trim, Metal Closures, Expansion Joints, Joint Intersections, and Miscellaneous Fabrications: 12 inches long and in required profile. Include fasteners and other exposed accessories.
 - 3. Accessories and Miscellaneous Materials: Full-size Sample.

- D. Qualification Data: For qualified fabricator.

- E. Maintenance Data: For sheet metal flashing, trim, and accessories to include in maintenance manuals.

- F. Warranty: Sample of special warranty.

1.5 QUALITY ASSURANCE

- A. Fabricator Qualifications: Shop that employs skilled workers who custom fabricate sheet metal flashing and trim similar to that required for this Project and whose products have a record of successful in-service performance.
- B. Sheet Metal Flashing and Trim Standard: Comply with SMACNA's "Architectural Sheet Metal Manual" unless more stringent requirements are specified or shown on Drawings.
- C. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.
 - 1. Build mockup of typical roof eave, including built-in gutter fascia, fascia trim and apron flashing, approximately 10 feet long, including supporting construction cleats, seams, attachments, underlayment, and accessories.
 - 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Design Professional specifically approves such deviations in writing.
 - 3. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
- D. Preinstallation Conference: Conduct conference at Project site.
 - 1. Meet with Owner, Design Professional, Owner's insurer if applicable, Installer, and installers whose work interfaces with or affects sheet metal flashing and trim including installers of roofing materials, roof accessories, unit skylights, and roof-mounted equipment.
 - 2. Review methods and procedures related to sheet metal flashing and trim.
 - 3. Examine substrate conditions for compliance with requirements, including flatness and attachment to structural members.
 - 4. Review special roof details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that will affect sheet metal flashing.
 - 5. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Do not store sheet metal flashing and trim materials in contact with other materials that might cause staining, denting, or other surface damage. Store sheet metal flashing and trim materials away from uncured concrete and masonry.
- B. Protect strippable protective covering on sheet metal flashing and trim from exposure to sunlight and high humidity, except to the extent necessary for the period of sheet metal flashing and trim installation.

1.7 WARRANTY

- A. Special Warranty on Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace sheet metal flashing and trim that shows evidence of deterioration of factory-applied finishes within specified warranty period.
 - 1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
 - b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 - 2. Finish Warranty Period: 20 years from date of Substantial Completion.
- B. Coordination with PVC Roof: All low-slope metal flashings associated with PVC membrane roofing must be installed by PVC membrane installer and covered under the PVC membrane edge-to-edge warranty. This includes flashing, counter flashing copings, roof edge flashing, roof penetrations and roof drains.

PART 2 - PRODUCTS

2.1 SHEET METALS

- A. General: Protect mechanical and other finishes on exposed surfaces from damage by applying a strippable, temporary protective film before shipping.
- B. Aluminum Sheet: ASTM B 209, alloy as standard with manufacturer for finish required, with temper as required to suit forming operations and performance required.
 - 1. Surface: Smooth, flat.
 - 2. Factory Prime Coating: Where painting after installation is indicated, pretreat with white or light-colored, factory-applied, baked-on epoxy primer coat; minimum dry film thickness of 0.2 mil.
 - 3. Exposed Coil-Coated Finishes:
 - a. Two-Coat Fluoropolymer: AAMA 620. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - 4. Color: As selected by Design Professional from manufacturer's full range.
 - 5. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil.
- C. Metallic-Coated Steel Sheet: Restricted flatness steel sheet, metallic coated by the hot-dip process and prepainted by the coil-coating process to comply with ASTM A 755/A 755M.

1. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A 792/A 792M, Class AZ50 coating designation, Grade 40; structural quality.
2. Surface: Smooth, flat..
3. Exposed Coil-Coated Finish:
 - a. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
4. Color: As selected by Design Professional from manufacturer's full range.
5. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil.

2.2 UNDERLAYMENT MATERIALS

- A. Polyethylene Sheet: 6-mil- thick polyethylene sheet complying with ASTM D 4397.
- B. Felt: ASTM D 226, Type II (No. 30), asphalt-saturated organic felt, nonperforated.
- C. Slip Sheet: Building paper, 3-lb/100 sq. ft. minimum, rosin sized.

2.3 MISCELLANEOUS MATERIALS

- A. General: Provide materials and types of fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation and recommended by manufacturer of primary sheet metal or manufactured item unless otherwise indicated.
- B. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads and recommended by manufacturer of primary sheet metal or manufactured item.
 1. General: Blind fasteners or self-drilling screws, gasketed, with hex-washer head.
 - a. Exposed Fasteners: Heads matching color of sheet metal using plastic caps or factory-applied coating.
 - b. Blind Fasteners: High-strength aluminum or stainless-steel rivets suitable for metal being fastened.
 - c. Spikes and Ferrules: Same material as gutter; with spike with ferrule matching internal gutter width.
 2. Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.
 3. Fasteners for Zinc-Coated (Galvanized) and Aluminum-Zinc Alloy-Coated Steel Sheet: Hot-dip galvanized steel according to ASTM A 153/A 153M or ASTM F 2329 or Series 300 stainless steel.
- C. Solder:

1. For Zinc-Coated (Galvanized) Steel: ASTM B 32, Grade Sn50, 50 percent tin and 50 percent lead or Grade Sn60, 60 percent tin and 40 percent lead.
- D. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch wide and 1/8 inch thick.
- E. Butyl Sealant: ASTM C 1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type expansion joints with limited movement.
- F. Epoxy Seam Sealer: Two-part, noncorrosive, aluminum seam-cementing compound, recommended by aluminum manufacturer for exterior nonmoving joints, including riveted joints.
- G. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.4 MANUFACTURED SHEET METAL FLASHING AND TRIM

- A. Reglets: Units of type, material, and profile indicated, formed to provide secure interlocking of separate reglet and counterflashing pieces, and compatible with flashing indicated.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Cheney Flashing Company.
 - b. Fry Reglet Corporation.
 - c. Heckmann Building Products Inc.
 - d. Hickman, W. P. Company.
 - e. Hohmann & Barnard, Inc.; STF Sawtooth Flashing.
 - f. Keystone Flashing Company, Inc.
 - g. National Sheet Metal Systems, Inc.
 - h. Sandell Manufacturing Company, Inc.
 2. Material: Aluminum, 0.024 inch thick or Galvanized steel, 0.022 inch thick.
 3. Surface-Mounted Type: Provide with slotted holes for fastening to substrate, with neoprene or other suitable weatherproofing washers, and with channel for sealant at top edge.
 4. Concrete Type: Provide temporary closure tape to keep reglet free of concrete materials, special fasteners for attaching reglet to concrete forms, and guides to ensure alignment of reglet section ends.
 5. Masonry Type: Provide with offset top flange for embedment in masonry mortar joint.
 6. Accessories:
 - a. Flexible-Flashing Retainer: Provide resilient plastic or rubber accessory to secure flexible flashing in reglet where clearance does not permit use of standard metal counterflashing or where Drawings show reglet without metal counterflashing.
 - b. Counterflashing Wind-Restraint Clips: Provide clips to be installed before counterflashing to prevent wind uplift of counterflashing lower edge.

7. Finish: Manufacturer's standard color coating.

2.5 FABRICATION, GENERAL

- A. General: Custom fabricate sheet metal flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, geometry, metal thickness, and other characteristics of item indicated. Fabricate items at the shop to greatest extent possible.
 1. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.
 2. Obtain field measurements for accurate fit before shop fabrication.
 3. Form sheet metal flashing and trim without excessive oil canning, buckling, and tool marks and true to line and levels indicated, with exposed edges folded back to form hems.
 4. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces exposed to view.
- B. Fabrication Tolerances: Fabricate sheet metal flashing and trim that is capable of installation to tolerances specified in MCA's "Guide Specification for Residential Metal Roofing."
- C. Sealed Joints: Form nonexpansion but movable joints in metal to accommodate elastomeric sealant.
- D. Expansion Provisions: Where lapped expansion provisions cannot be used, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with butyl sealant concealed within joints.
- E. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.
- F. Fabricate cleats and attachment devices of sizes as recommended by SMACNA's "Architectural Sheet Metal Manual" for application, but not less than thickness of metal being secured.
- G. Seams: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with elastomeric sealant unless otherwise recommended by sealant manufacturer for intended use. Rivet joints where necessary for strength.
- H. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints where necessary for strength.
- I. Do not use graphite pencils to mark metal surfaces.

2.6 ROOF DRAINAGE SHEET METAL FABRICATIONS

- A. Hanging Gutters: Fabricate to cross section indicated, complete with end pieces, outlet tubes, and other accessories as required. Fabricate in minimum 96-inch- long sections. Furnish flat-stock gutter spacers and gutter brackets fabricated from same metal as gutters, of size recommended by SMACNA but not less than twice the gutter thickness. Fabricate expansion joints, expansion-joint covers, gutter bead reinforcing bars, and gutter accessories from same metal as gutters.

1. Gutter Style: As indicated on drawings..
 2. Expansion Joints: Lap type.
 3. Accessories: Continuous removable leaf screen with sheet metal frame and hardware cloth screen.
 4. Gutters with Girth up to 15 Inches: Fabricate from the following materials:
 - a. Aluminum: 0.040 inch thick.
- B. Downspouts: Fabricate rectangular open downspouts complete with mitered elbows. Furnish with metal hangers, from same material as downspouts, and anchors.
1. Hanger Style: Manufacturer's standard.
 2. Fabricate from the following materials:
 - a. Aluminum: 0.024 inch thick.
- C. Parapet Scuppers: Fabricate scuppers of dimensions required with closure flange trim to exterior, 4-inch-wide wall flanges to interior, and base extending 4 inches beyond cant or tapered strip into field of roof. Fasten gravel guard angles to base of scupper. Fabricate from the following materials:
1. Aluminum: 0.032 inch thick.
- D. Conductor Heads: Fabricate conductor heads with flanged back and stiffened top edge and of dimensions and shape indicated complete with outlet tubes, exterior flange trim, and built-in overflows. Fabricate from the following materials:
1. Aluminum: 0.032 inch thick.

2.7 LOW-SLOPE ROOF SHEET METAL FABRICATIONS

- A. Roof-Edge Flashing (Drip Edge) and Fascia Cap: Fabricate in minimum 96-inch- long, but not exceeding 10-foot- long, sections. Furnish with 6-inch- wide, joint cover plates.
1. Joint Style: Lap, 4 inches.
 2. Fabricate with scuppers spaced 10 feet apart, of dimensions required with 4-inch- wide flanges and base extending 4 inches beyond cant or tapered strip into field of roof. Fasten guard angles to base of scupper.
 3. Fabricate from the following materials:
 - a. Aluminum: 0.040 inch thick.
- B. Copings: Fabricate in minimum 96-inch- long, but not exceeding 10-foot- long, sections. Fabricate joint plates of same thickness as copings. Furnish with continuous cleats to support edge of external leg and drill elongated holes for fasteners on interior leg. Miter corners, seal, and solder or weld watertight.

1. Coping Profile: See drawings..
2. Joint Style: Butt, with 12-inch- wide, concealed backup plate and 6-inch- wide, exposed cover plates.
3. Fabricate from the following materials:
 - a. Galvanized Steel: 0.028 inch thick.

C. Base Flashing: Fabricate from the following materials:

1. Aluminum: 0.040 inch Insert thickness thick.

D. Counterflashing: Fabricate from the following materials:

1. Aluminum: 0.032 inch thick.
2. Galvanized Steel: 0.022 inch thick.
3. Aluminum-Zinc Alloy-Coated Steel: 0.022 inch thick.

E. Flashing Receivers: Fabricate from the following materials:

1. Aluminum: 0.032 inch thick.
2. Galvanized Steel: 0.022 inch thick.
3. Aluminum-Zinc Alloy-Coated Steel: 0.022 inch thick.

F. Roof-Penetration Flashing: Fabricate from the following materials:

1. Galvanized Steel: 0.028 inch thick.
2. Aluminum-Zinc Alloy-Coated Steel: 0.028 inch thick.

G. Roof-Drain Flashing: Fabricate from the following materials:

1. Galvanized Steel: 0.028 inch thick.
2. Aluminum-Zinc Alloy-Coated Steel: 0.028 inch thick.

2.8 MISCELLANEOUS SHEET METAL FABRICATIONS

A. Equipment Support Flashing: Fabricate from the following materials:

1. Galvanized Steel: 0.028 inch thick.
2. Aluminum-Zinc Alloy-Coated Steel: 0.028 inch thick.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions and other conditions affecting performance of the Work.

1. Verify compliance with requirements for installation tolerances of substrates.

2. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
- B. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 UNDERLAYMENT INSTALLATION

- A. General: Install underlayment as indicated on Drawings.
- B. Polyethylene Sheet: Install polyethylene sheet with adhesive for anchorage to minimize use of mechanical fasteners under sheet metal flashing and trim. Apply in shingle fashion to shed water, with lapped and taped joints of not less than 2 inches.
- C. Felt Underlayment: Install felt underlayment with adhesive for temporary anchorage to minimize use of mechanical fasteners under sheet metal flashing and trim. Apply in shingle fashion to shed water, with lapped joints of not less than 2 inches.

3.3 INSTALLATION, GENERAL

- A. General: Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement. Use fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.
 1. Install sheet metal flashing and trim true to line and levels indicated. Provide uniform, neat seams with minimum exposure of solder, welds, and sealant.
 2. Install sheet metal flashing and trim to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.
 3. Space cleats not more than 12 inches apart. Anchor each cleat with two fasteners. Bend tabs over fasteners.
 4. Install exposed sheet metal flashing and trim without excessive oil canning, buckling, and tool marks.
 5. Install sealant tape where indicated.
 6. Torch cutting of sheet metal flashing and trim is not permitted.
 7. Do not use graphite pencils to mark metal surfaces.
- B. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating or by other permanent separation as recommended by SMACNA.
 1. Coat back side of uncoated aluminum sheet metal flashing and trim with bituminous coating where flashing and trim will contact wood, ferrous metal, or cementitious construction.

2. Underlayment: Where installing metal flashing directly on cementitious or wood substrates, install a course of felt underlayment and cover with a slip sheet or install a course of polyethylene sheet.
- C. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently watertight, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with sealant concealed within joints.
- D. Seal joints as shown and as required for watertight construction.
1. Where sealant-filled joints are used, embed hooked flanges of joint members not less than 1 inch into sealant. Form joints to completely conceal sealant. When ambient temperature at time of installation is moderate, between 40 and 70 deg F, set joint members for 50 percent movement each way. Adjust setting proportionately for installation at higher ambient temperatures. Do not install sealant-type joints at temperatures below 40 deg F.
 2. Prepare joints and apply sealants to comply with requirements in Division 7 Section "Joint Sealants."
- E. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter. Pre-tin edges of sheets to be soldered to a width of 1-1/2 inches, except reduce pre-tinning where pre-tinned surface would show in completed Work.
1. Do not solder metallic-coated steel and aluminum sheet.
 2. Do not use torches for soldering. Heat surfaces to receive solder and flow solder into joint. Fill joint completely. Completely remove flux and spatter from exposed surfaces.
- F. Rivets: Rivet joints in uncoated aluminum where necessary for strength.

3.4 ROOF DRAINAGE SYSTEM INSTALLATION

- A. General: Install sheet metal roof drainage items to produce complete roof drainage system according to SMACNA recommendations and as indicated. Coordinate installation of roof perimeter flashing with installation of roof drainage system.
- B. Hanging Gutters: Join sections with riveted and soldered joints or with lapped joints sealed with sealant. Provide for thermal expansion. Attach gutters at eave or fascia to firmly anchored gutter brackets spaced not more than 36 inches apart. Provide end closures and seal watertight with sealant. Slope to downspouts.
1. Fasten gutter spacers to front and back of gutter.
 2. Loosely lock straps to front gutter bead and anchor to roof deck.
 3. Anchor back of gutter that extends onto roof deck with cleats spaced not more than 24 inches apart.
 4. Install gutter with expansion joints at locations indicated, but not exceeding, 40 feet apart. Install expansion-joint caps.
 5. Install continuous gutter screens on gutters with noncorrosive fasteners, removable for cleaning gutters.

- C. Downspouts: Join sections with 1-1/2-inch telescoping joints.
 - 1. Provide hangers with fasteners designed to hold downspouts securely to walls. Locate hangers at top and bottom and at approximately 60 inches o.c. in between.
 - 2. Provide elbows at base of downspout to direct water away from building.
 - 3. Connect downspouts to underground drainage system indicated.
- D. Splash Pans: Install where downspouts discharge on low-slope roofs. Set in elastomeric sealant compatible with roofing membrane.
- E. Parapet Scuppers: Install scuppers where indicated through parapet. Continuously support scupper, set to correct elevation, and seal flanges to interior wall face, over cants or tapered edge strips, and under roofing membrane.
 - 1. Anchor scupper closure trim flange to exterior wall and solder or seal with elastomeric sealant to scupper.
 - 2. Loosely lock front edge of scupper with conductor head.
 - 3. Solder or seal with elastomeric sealant exterior wall scupper flanges into back of conductor head.
- F. Conductor Heads: Anchor securely to wall with elevation of conductor head rim 1 inch below scupper discharge.

3.5 ROOF FLASHING INSTALLATION

- A. General: Install sheet metal flashing and trim to comply with performance requirements, sheet metal manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, set units true to line, and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.
- B. Roof Edge Flashing ES-1 Rated: Anchor to resist uplift and outward forces according to recommendations in SMACNA's "Architectural Sheet Metal Manual" and as indicated. Interlock bottom edge of roof edge flashing with continuous cleat anchored to substrate at staggered 3-inch centers.
- C. Copings ES-1 Rated: Anchor to resist uplift and outward forces according to recommendations in SMACNA's "Architectural Sheet Metal Manual" and as indicated.
 - 1. Interlock exterior bottom edge of coping with continuous cleat anchored to substrate at 24-inch centers.
 - 2. Anchor interior leg of coping with washers and screw fasteners through slotted holes at 24-inch centers.
- D. Pipe or Post Counterflashing: Install counterflashing umbrella with close-fitting collar with top edge flared for elastomeric sealant, extending a minimum of 4 inches over base flashing. Install stainless-steel draw band and tighten.
- E. Counterflashing: Coordinate installation of counterflashing with installation of base flashing. Insert counterflashing in reglets or receivers and fit tightly to base flashing. Extend counterflashing 4 inches over base flashing. Lap counterflashing joints a minimum of 4 inches and bed with sealant. Secure in a waterproof manner by means interlocking folded seam or blind rivets and sealant.

- F. Roof-Penetration Flashing: Coordinate installation of roof-penetration flashing with installation of roofing and other items penetrating roof. Seal with elastomeric sealant and clamp flashing to pipes that penetrate roof.

3.6 MISCELLANEOUS FLASHING INSTALLATION

- A. Equipment Support Flashing: Coordinate installation of equipment support flashing with installation of roofing and equipment. Weld or seal flashing with elastomeric sealant to equipment support member. Slip flash all curbs.

3.7 ERECTION TOLERANCES

- A. Installation Tolerances: Shim and align sheet metal flashing and trim within installed tolerance of 1/4 inch in 20 feet on slope and location lines as indicated and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.
- B. Installation Tolerances: Shim and align sheet metal flashing and trim within installed tolerances specified in MCA's "Guide Specification for Residential Metal Roofing."

3.8 CLEANING AND PROTECTION

- A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.
- B. Clean and neutralize flux materials. Clean off excess solder.
- C. Clean off excess sealants.
- D. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed unless otherwise indicated in manufacturer's written installation instructions. On completion of installation, remove unused materials and clean finished surfaces. Maintain in a clean condition during construction.
- E. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 076200

SECTION 078413 - THROUGH-PENETRATION FIRESTOP SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes through-penetration firestop systems for penetrations through fire-resistance-rated constructions, including both empty openings and openings containing penetrating items.
- B. Related Sections include the following:
 - 1. Division 7 Section "Fire-Resistive Joint Systems."
 - 2. Division 21 Sections specifying fire-suppression piping penetrations.
 - 3. Division 23 Sections specifying duct and piping penetrations.
 - 4. Division 26 Sections specifying cable and conduit penetrations.

1.3 PERFORMANCE REQUIREMENTS

- A. General: For penetrations through fire-resistance-rated constructions, including both empty openings and openings containing penetrating items, provide through-penetration firestop systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated.
 - 1. Fire-resistance-rated walls including fire walls, fire partitions, fire barriers, and smoke barriers.
 - 2. Fire-resistance-rated horizontal assemblies including floors, floor/ceiling assemblies, and ceiling membranes of roof/ceiling assemblies.
- B. Rated Systems: Provide through-penetration firestop systems with the following ratings determined per ASTM E 814 or UL 1479:
 - 1. F-Rated Systems: Provide through-penetration firestop systems with F-ratings indicated, but not less than that equaling or exceeding fire-resistance rating of constructions penetrated.
 - 2. L-Rated Systems: Where through-penetration firestop systems are indicated in smoke barriers, provide through-penetration firestop systems with L-ratings of not more than 3.0 cfm/sq. ft at both ambient temperatures and 400 deg F.

- C. For through-penetration firestop systems exposed to view, traffic, moisture, and physical damage, provides products that, after curing, do not deteriorate when exposed to these conditions both during and after construction.
 - 1. For piping penetrations for plumbing and wet-pipe sprinkler systems, provide moisture-resistant through-penetration firestop systems.
 - 2. For floor penetrations with annular spaces exceeding 4 inches in width and exposed to possible loading and traffic, provide firestop systems capable of supporting floor loads involved, either by installing floor plates or by other means.
 - 3. For penetrations involving insulated piping, provide through-penetration firestop systems not requiring removal of insulation.
- D. For through-penetration firestop systems exposed to view, provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For each through-penetration firestop system, show each type of construction condition penetrated, relationships to adjoining construction, and type of penetrating item. Include firestop design designation of qualified testing and inspecting agency that evidences compliance with requirements for each condition indicated.
 - 1. Submit documentation, including illustrations, from a qualified testing and inspecting agency that is applicable to each through-penetration firestop system configuration for construction and penetrating items.
 - 2. Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular through-penetration firestop condition, submit illustration, with modifications marked, approved by through-penetration firestop system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.
- C. Qualification Data: For Installer.
- D. Product Certificates: For through-penetration firestop system products, signed by product manufacturer.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: A firm experienced in installing through-penetration firestop systems similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful performance.
- B. Source Limitations: Obtain through-penetration firestop systems, for each kind of penetration and construction condition indicated, through one source from a single manufacturer.

- C. Fire-Test-Response Characteristics: Provide through-penetration firestop systems that comply with the following requirements and those specified in Part 1 "Performance Requirements" Article:
 - 1. Firestopping tests are performed by a qualified testing and inspecting agency. A qualified testing and inspecting agency is UL, or another agency performing testing and follow-up inspection services for firestop systems acceptable to authorities having jurisdiction.
 - 2. Through-penetration firestop systems are identical to those tested per testing standard referenced in "Part 1 Performance Requirements" Article. Provide rated systems complying with the following requirements:
 - a. Through-penetration firestop system products bear classification marking of qualified testing and inspecting agency.
 - b. Through-penetration firestop systems correspond to those indicated by reference to through-penetration firestop system designations listed by the following:
 - 1) UL in its "Fire Resistance Directory."

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver through-penetration firestop system products to Project site in original, unopened containers or packages with intact and legible manufacturers' labels identifying product and manufacturer, date of manufacture, lot number, shelf life if applicable, qualified testing and inspecting agency's classification marking applicable to Project, curing time, and mixing instructions for multi-component materials.
- B. Store and handle materials for through-penetration firestop systems to prevent their deterioration or damage due to moisture, temperature changes, contaminants, or other causes.

1.7 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install through-penetration firestop systems when ambient or substrate temperatures are outside limits permitted by through-penetration firestop system manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.
- B. Ventilate through-penetration firestop systems per manufacturer's written instructions by natural means or, where this is inadequate, forced-air circulation.

1.8 COORDINATION

- A. Coordinate construction of openings and penetrating items to ensure that through-penetration firestop systems are installed according to specified requirements.
- B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate through-penetration firestop systems.

- C. Notify Owner's inspecting agency at least seven days in advance of through-penetration firestop system installations; confirm dates and times on days preceding each series of installations.
- D. Do not cover up through-penetration firestop system installations that will become concealed behind other construction until each installation has been examined by building inspector, if required by authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide one of the through-penetration firestop systems indicated for each application that are produced by one of the following manufacturers:
 - 1. A/D Fire Protection Systems Inc.
 - 2. Grace, W. R. & Co. - Conn.
 - 3. Hilti, Inc.
 - 4. Johns Manville.
 - 5. Nelson Firestop Products.
 - 6. NUCO Inc.
 - 7. RectorSeal Corporation (The).
 - 8. Specified Technologies Inc.
 - 9. 3M; Fire Protection Products Division.
 - 10. Tremco; Sealant/Weatherproofing Division.
 - 11. USG Corporation.

2.2 FIRESTOPPING, GENERAL

- A. Compatibility: Provide through-penetration firestop systems that are compatible with one another; with the substrates forming openings; and with the items, if any, penetrating through-penetration firestop systems, under conditions of service and application, as demonstrated by through-penetration firestop system manufacturer based on testing and field experience.
- B. Accessories: Provide components for each through-penetration firestop system that are needed to install fill materials and to comply with Part 1 "Performance Requirements" Article. Use only components specified by through-penetration firestop system manufacturer and approved by qualified testing and inspecting agency for firestop systems indicated. Accessories include, but are not limited to, the following items:
 - 1. Permanent forming/damming/backing materials, including the following:
 - a. Slag-/rock-wool-fiber insulation.
 - b. Sealants used in combination with other forming/damming/backing materials to prevent leakage of fill materials in liquid state.
 - c. Fire-rated form board.
 - d. Fillers for sealants.

2. Temporary forming materials.
3. Substrate primers.
4. Collars.
5. Steel sleeves.

2.3 FILL MATERIALS

- A. General: Provide through-penetration firestop systems containing the types of fill materials indicated by referencing the types of materials described in this Article. Fill materials are those referred to in directories of referenced testing and inspecting agencies as "fill," "void," or "cavity" materials.
- B. Latex Sealants: Single-component latex formulations that after cure do not re-emulsify during exposure to moisture.
- C. Firestop Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.
- D. Intumescent Composite Sheets: Rigid panels consisting of aluminum-foil-faced elastomeric sheet bonded to galvanized steel sheet.
- E. Intumescent Putties: Non-hardening dielectric, water-resistant putties containing no solvents, inorganic fibers, or silicone compounds.
- F. Intumescent Wrap Strips: Single-component intumescent elastomeric sheets with aluminum foil on one side.
- G. Mortars: Prepackaged dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers, and lightweight aggregate formulated for mixing with water at Project site to form a non-shrinking, homogeneous mortar.
- H. Pillows/Bags: Reusable heat-expanding pillows/bags consisting of glass-fiber cloth cases filled with a combination of mineral-fiber, water-insoluble expansion agents, and fire-retardant additives.
- I. Silicone Foams: Multi-component, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, non-shrinking foam.
- J. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below:
 1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces, and nonsag formulation for openings in vertical and other surfaces requiring a non-slumping, gunnable sealant, unless indicated firestop system limits use to nonsag grade for both opening conditions.
 2. Grade for Horizontal Surfaces: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces.
 3. Grade for Vertical Surfaces: Nonsag formulation for openings in vertical and other surfaces.

2.4 MIXING

- A. For those products requiring mixing before application, comply with through-penetration firestop system manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of work.
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Cleaning: Clean out openings immediately before installing through-penetration firestop systems to comply with firestop system manufacturer's written instructions and with the following requirements:
 - 1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of through-penetration firestop systems.
 - 2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with through-penetration firestop systems. Remove loose particles remaining from cleaning operation.
 - 3. Remove laitance and form-release agents from concrete.
- B. Priming: Prime substrates where recommended in writing by through-penetration firestop system manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.
- C. Masking Tape: Use masking tape to prevent through-penetration firestop systems from contacting adjoining surfaces that will remain exposed on completion of Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove smears from firestop system materials. Remove tape as soon as possible without disturbing firestop system's seal with substrates.

3.3 THROUGH-PENETRATION FIRESTOP SYSTEM INSTALLATION

- A. General: Install through-penetration firestop systems to comply with Part 1 "Performance Requirements" Article and with firestop system manufacturer's written installation instructions and published drawings for products and applications indicated.

- B. Install forming/damming/backing materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.
 - 1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of firestop systems.
- C. Install fill materials for firestop systems by proven techniques to produce the following results:
 - 1. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items as required to achieve fire-resistance ratings indicated.
 - 2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
 - 3. For fill materials that will remain exposed after completing Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 IDENTIFICATION

- A. Identify through-penetration firestop systems with preprinted metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches of edge of the firestop systems so that labels will be visible to anyone seeking to remove penetrating items or firestop systems. Use mechanical fasteners for metal labels. For plastic labels, use self-adhering type with adhesives capable of permanently bonding labels to surfaces on which labels are placed and, in combination with label material, will result in partial destruction of label if removal is attempted. Include the following information on labels:
 - 1. The words "Warning - Through-Penetration Firestop System - Do Not Disturb. Notify Building Management of Any Damage."

3.5 CLEANING AND PROTECTING

- A. Clean off excess fill materials adjacent to openings as Work progresses by methods and with cleaning materials that are approved in writing by through-penetration firestop system manufacturers and that do not damage materials in which openings occur.
- B. Provide final protection and maintain conditions during and after installation that ensure that through-penetration firestop systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated through-penetration firestop systems immediately and install new materials to produce systems complying with specified requirements.

END OF SECTION 078413

SECTION 078446 - FIRE-RESISTIVE JOINT SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes fire-resistive joint systems for the following:
 - 1. Floor-to-floor joints.
 - 2. Floor-to-wall joints.
 - 3. Head-of-wall joints.
 - 4. Wall-to-wall joints.
- B. Related Sections include the following:
 - 1. Division 7 Section "Through-Penetration Firestop Systems" for systems installed in openings in walls and floors with and without penetrating items.
 - 2. Division 7 Section "Joint Sealants" for non-fire-resistive joint sealants.

1.3 PERFORMANCE REQUIREMENTS

- A. General: Provide fire-resistive joint systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of assembly in which fire-resistive joint systems are installed.
- B. Joint Systems in and between Fire-Resistance-Rated Constructions: Provide systems with assembly ratings equaling or exceeding the fire-resistance ratings of construction that they join, as determined by UL 2079.
 - 1. Load-bearing capabilities as determined by evaluation during the time of test.
- C. For fire-resistive systems exposed to view, provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For each fire-resistive joint system, show each kind of construction condition in which joints are installed; also show relationships to adjoining construction. Include fire-resistive joint system design designation of testing and inspecting agency acceptable to

authorities having jurisdiction that demonstrates compliance with requirements for each condition indicated.

1. Submit documentation, including illustrations, from a qualified testing and inspecting agency that is applicable to each fire-resistive joint system configuration for construction and penetrating items.
- C. Product Certificates: For each type of fire-resistive joint system, signed by product manufacturer.
- D. Qualification Data: For Installer.
- E. Evaluation Reports: Evidence of fire-resistive joint systems' compliance with ICBO ES AC30, from the ICBO Evaluation Service.
- F. Research/Evaluation Reports: For each type of fire-resistive joint system.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: A firm that has been approved by FMG according to FMG 4991, "Approval of Firestop Contractors."
- B. Installation Responsibility: Assign installation of through-penetration firestop systems and fire-resistive joint systems in Project to a single qualified installer.
- C. Source Limitations: Obtain fire-resistive joint systems, for each kind of joint and construction condition indicated, through one source from a single manufacturer.
- D. Fire-Test-Response Characteristics: Provide fire-resistive joint systems that comply with the following requirements and those specified in Part 1 "Performance Requirements" Article:
 1. Fire-resistive joint systems are identical to those tested per methods indicated in Part 1 "Performance Requirements" Article and comply with the following:
 - a. Fire-resistive joint system products bear classification marking of qualified testing and inspecting agency.
 - b. Fire-resistive joint systems correspond to those indicated by referencing system designations of the qualified testing and inspecting agency.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver fire-resistive joint system products to Project site in original, unopened containers or packages with qualified testing and inspecting agency's classification marking applicable to Project and with intact and legible manufacturers' labels identifying product and manufacturer, date of manufacture, lot number, shelf life, curing time, and mixing instructions for multicomponent materials.
- B. Store and handle materials for fire-resistive joint systems to prevent their deterioration or damage due to moisture, temperature changes, contaminants, or other causes.

1.7 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install fire-resistive joint systems when ambient or substrate temperatures are outside limits permitted by fire-resistive joint system manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.
- B. Ventilate fire-resistive joint systems per manufacturer's written instructions by natural means or, if this is inadequate, forced-air circulation.

1.8 COORDINATION

- A. Coordinate construction of joints to ensure that fire-resistive joint systems are installed according to specified requirements.
- B. Coordinate sizing of joints to accommodate fire-resistive joint systems.
- C. Do not cover up fire-resistive joint system installations that will become concealed behind other construction until Owner's inspecting agency and building inspector of authorities having jurisdiction have examined each installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide one of the fire-resistive joint systems indicated for each application that are produced by one of the following manufacturer's:
 - 1. A/D Fire Protection Systems Inc.
 - 2. Grace, W.R. & Co. – Conn.
 - 3. EMSEAL
 - 3. Hilti, Inc.
 - 4. Johns Manville
 - 5. Nelson Firestop Products.
 - 6. NUCO Inc.
 - 7. RectorSeal Corporation (The).
 - 8. Specified Technologies Inc.
 - 9. 3M; Fire Protection Products Division.
 - 10. Tremco; Sealant/Weatherproofing Division.
 - 11. USG Corporation.

2.2 FIRE-RESISTIVE JOINT SYSTEMS

- A. Compatibility: Provide fire-resistive joint systems that are compatible with joint substrates, under conditions of service and application, as demonstrated by fire-resistive joint system manufacturer based on testing and field experience.

- B. Accessories: Provide components of fire-resistive joint systems, including primers and forming materials, that are needed to install fill materials and to comply with Part 1 "Performance Requirements" Article. Use only components specified by fire-resistive joint system manufacturer and approved by the qualified testing and inspecting agency for systems indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for joint configurations, substrates, and other conditions affecting performance of work.
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Cleaning: Clean joints immediately before installing fire-resistive joint systems to comply with fire-resistive joint system manufacturer's written instructions and the following requirements:
 - 1. Remove from surfaces of joint substrates foreign materials that could interfere with adhesion of fill materials.
 - 2. Clean joint substrates to produce clean, sound surfaces capable of developing optimum bond with fill materials. Remove loose particles remaining from cleaning operation.
 - 3. Remove laitance and form-release agents from concrete.
- B. Priming: Prime substrates where recommended in writing by fire-resistive joint system manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.
- C. Masking Tape: Use masking tape to prevent fill materials of fire-resistive joint system from contacting adjoining surfaces that will remain exposed on completion of Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove smears from fire-resistive joint system materials. Remove tape as soon as possible without disturbing fire-resistive joint system's seal with substrates or damaging adjoining surfaces.

3.3 INSTALLATION

- A. General: Install fire-resistive joint systems to comply with Part 1 "Performance Requirements" Article and fire-resistive joint system manufacturer's written installation instructions for products and applications indicated.
- B. Install forming/packing/backing materials and other accessories of types required to support fill materials during their application and in position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.

- C. Install fill materials for fire-resistive joint systems by proven techniques to produce the following results:
 - 1. Fill voids and cavities formed by openings and forming/packing/backing materials as required to achieve fire-resistance ratings indicated.
 - 2. Apply fill materials so they contact and adhere to substrates formed by joints.
 - 3. For fill materials that will remain exposed after completing Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 CLEANING AND PROTECTING

- A. Clean off excess fill materials adjacent to joints as Work progresses by methods and with cleaning materials that are approved in writing by fire-resistive joint system manufacturers and that do not damage materials in which openings occur.
- B. Provide final protection and maintain conditions during and after installation that ensure fire-resistive joint systems are without damage or deterioration at time of Substantial Completion. If damage or deterioration occurs despite such protection, cut out and remove damaged or deteriorated fire-resistive joint systems immediately and install new materials to produce fire-resistive joint systems complying with specified requirements.

END OF SECTION 078446

SECTION 079200 - JOINT SEALANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes joint sealants for the following applications:
 - 1. Exterior joints in the following vertical surfaces and horizontal nontraffic surfaces:
 - a. Joints between metal panels.
 - b. Joints between different materials listed above.
 - c. Perimeter joints between materials listed above and frames of doors, windows, and louvers.
 - d. Other joints as indicated.
 - 2. Interior joints in the following vertical surfaces and horizontal nontraffic surfaces:
 - a. Control and expansion joints on exposed interior surfaces of exterior walls.
 - b. Perimeter joints of exterior openings where indicated.
 - c. Tile control and expansion joints.
 - d. Perimeter joints between interior wall surfaces and frames of interior doors, and windows.
 - e. Joints between plumbing fixtures and adjoining walls, floors, and counters.
 - f. Other joints as indicated.
 - 3. Interior joints in the following horizontal traffic surfaces:
 - a. Control and expansion joints in tile flooring.
 - b. Other joints as indicated.
- B. Related Sections include the following:
 - 1. Division 2 Section "Pavement Joint Sealants" for sealing joints in pavements, walkways, and curbing.
 - 2. Division 7 Section "Fire-Resistive Joint Systems" for sealing joints in fire-resistance-rated construction.
 - 3. Division 8 Section "Glazing" for glazing sealants.
 - 4. Division 9 Section "Ceramic Tile" for sealing tile joints.
 - 5. Division 9 Section "Acoustical Panel Ceilings" for sealing edge moldings at perimeters of acoustical ceilings.

1.3 PERFORMANCE REQUIREMENTS

- A. Provide elastomeric joint sealants that establish and maintain watertight and airtight continuous joint seals without staining or deteriorating joint substrates.
- B. Provide joint sealants for interior applications that establish and maintain airtight and water-resistant continuous joint seals without staining or deteriorating joint substrates.

1.4 SUBMITTALS

- A. Product Data: For each joint-sealant product indicated.
- B. Samples for Initial Selection: Manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.
- C. Samples for Verification: For each type and color of joint sealant required, provide Samples with joint sealants in 1/2-inch- wide joints formed between two 6-inch- long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.
- D. Product Certificates: For each type of joint sealant and accessory, signed by product manufacturer.
- E. SWRI Validation Certificate: For each elastomeric sealant specified to be validated by SWRI's Sealant Validation Program.
- F. Qualification Data: For Installer and testing agency.
- G. Warranties: Special warranties specified in this Section.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized Installer who is approved or licensed for installation of elastomeric sealants required for this Project.
- B. Source Limitations: Obtain each type of joint sealant through one source from a single manufacturer.

1.6 PROJECT CONDITIONS

- A. Do not proceed with installation of joint sealants under the following conditions:
 - 1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F.
 - 2. When joint substrates are wet.
 - 3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
 - 4. Contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

1.7 WARRANTY

- A. Special Installer's Warranty: Installer's standard form in which Installer agrees to repair or replace elastomeric joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
 - 1. Warranty Period: Two years from date of Substantial Completion.
- B. Special Manufacturer's Warranty: Manufacturer's standard form in which elastomeric sealant manufacturer agrees to furnish elastomeric joint sealants to repair or replace those that do not comply with performance and other requirements specified in this Section within specified warranty period.
 - 1. Warranty Period: Ten years from date of Substantial Completion.
- C. Special warranties specified in this Article exclude deterioration or failure of elastomeric joint sealants from the following:
 - 1. Movement of the structure resulting in stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression caused by structural settlement or errors attributable to design or construction.
 - 2. Disintegration of joint substrates from natural causes exceeding design specifications.
 - 3. Mechanical damage caused by individuals, tools, or other outside agents.
 - 4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide one of the products listed in other Part 2 articles.

2.2 MATERIALS, GENERAL

- A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by sealant manufacturer, based on testing and field experience.
- B. VOC Content of Interior Sealants: Provide interior sealants and sealant primers that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
 - 1. Sealants: 250 g/L.
 - 2. Sealant Primers for Nonporous Substrates: 250 g/L.
 - 3. Sealant Primers for Porous Substrates: 775 g/L.

- C. Colors of Exposed Joint Sealants: As selected by Design Professional from manufacturer's full range.

2.3 ELASTOMERIC JOINT SEALANTS

- A. Elastomeric Sealants: Comply with ASTM C 920 and other requirements indicated for each liquid-applied chemically curing sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.
- B. Stain-Test-Response Characteristics: Where elastomeric sealants are specified to be non-staining to porous substrates, provide products that have undergone testing according to ASTM C 1248 and have not stained porous joint substrates indicated for Project.
- C. Single-Component Neutral-Curing Silicone Sealant:
 - 1. Products:
 - a. Dow Corning Corporation; 790.
 - b. GE Silicones; SilPruf LM SCS2700.
 - c. Tremco; Spectrem 1 (Basic).
 - d. GE Silicones; SilPruf SCS2000.
 - e. Pecora Corporation; 864.
 - f. Pecora Corporation; 890.
 - g. Polymeric Systems Inc.; PSI-641.
 - h. Sonneborn, Division of ChemRex Inc.; Omniseal.
 - i. Tremco; Spectrem 3.
 - j. Dow Corning Corporation; 791.
 - k. Dow Corning Corporation; 795
 - l. GE Silicones; SilPruf NB SCS9000.
 - m. GE Silicones; UltraPruf II SCS2900.
 - n. Pecora Corporation; 865.
 - o. Pecora Corporation; 895.
 - p. Pecora Corporation; 898.
 - 2. Type and Grade: S (single component) and NS (non-sag).
 - 3. Class: 100/50.
 - 4. Use Related to Exposure: NT (non-traffic).
 - 5. Uses Related to Joint Substrates: M, G, A, and, as applicable to joint substrates indicated, O.
 - a. Use O Joint Substrates: Coated glass, color anodic aluminum, aluminum coated with a high-performance coating, galvanized steel, marble, ceramic tile, and wood .
 - 6. Stain-Test-Response Characteristics: Non-staining to porous substrates per ASTM C 1248.
- D. Single-Component Mildew-Resistant Acid-Curing Silicone Sealant:

- 1. Products:

- a. Dow Corning Corporation; 786 Mildew Resistant.
 - b. GE Silicones; Sanitary SCS1700.
 - c. Tremco; Tremsil 200.
- 2. Type and Grade: S (single component) and NS (non-sag).
 - 3. Class: 25.
 - 4. Use Related to Exposure: NT (non-traffic).
 - 5. Uses Related to Joint Substrates: G, A, and, as applicable to joint substrates indicated, O.
 - a. Use O Joint Substrates: Coated glass, color anodic aluminum, aluminum coated with a high-performance coating, ceramic tile.

2.4 LATEX JOINT SEALANTS

- A. Latex Sealant: Comply with ASTM C 834, Type P, Grade NF.
- B. Products:
 - 1. Bostik Findley; Chem-Calk 600.
 - 2. Pecora Corporation; AC-20+.
 - 3. Schnee-Morehead, Inc.; SM 8200.
 - 4. Sonneborn, Division of ChemRex Inc.; Sonolac.
 - 5. Tremco; Tremflex 834.

2.5 JOINT-SEALANT BACKING

- A. General: Provide sealant backings of material and type that are non-staining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.
- B. Cylindrical Sealant Backings: ASTM C 1330, Type C (closed-cell material with a surface skin), O (open-cell material), B (bicellular material with a surface skin), or any of the preceding types, as approved in writing by joint-sealant manufacturer for joint application indicated, and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance:
- C. Elastomeric Tubing Sealant Backings: Neoprene, butyl, EPDM, or silicone tubing complying with ASTM D 1056, nonabsorbent to water and gas, and capable of remaining resilient at temperatures down to minus 26 deg F. Provide products with low compression set and of size and shape to provide a secondary seal, to control sealant depth, and to otherwise contribute to optimum sealant performance.
- D. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint where such adhesion would result in sealant failure. Provide self-adhesive tape where applicable.

2.6 MISCELLANEOUS MATERIALS

- A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.
- B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.
- C. Masking Tape: Non-staining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:
 - 1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
 - 2. Clean porous joint substrate surfaces by brushing, grinding, blast cleaning, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:
 - a. Concrete.
 - b. Unglazed surfaces of ceramic tile.
 - 3. Remove laitance and form-release agents from concrete.
 - 4. Clean nonporous surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following:
 - a. Metal.

- b. Glass.
 - c. Porcelain enamel.
 - d. Glazed surfaces of ceramic tile.
- B. Joint Priming: Prime joint substrates, where recommended in writing by joint-sealant manufacturer, based on preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.
- C. Masking Tape: Use masking tape where required to prevent contact of sealant with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF JOINT SEALANTS

- A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.
- B. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. Install sealant backings of type indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
- 1. Do not leave gaps between ends of sealant backings.
 - 2. Do not stretch, twist, puncture, or tear sealant backings.
 - 3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.
- D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.
- E. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
- 1. Place sealants so they directly contact and fully wet joint substrates.
 - 2. Completely fill recesses in each joint configuration.
 - 3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- F. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
- 1. Remove excess sealant from surfaces adjacent to joints.
 - 2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.

3. Provide concave joint configuration per Figure 5A in ASTM C 1193, unless otherwise indicated.
4. Provide flush joint configuration where indicated per Figure 5B in ASTM C 1193.
5. Provide recessed joint configuration of recess depth and at locations indicated per Figure 5C in ASTM C 1193.
 - a. Use masking tape to protect surfaces adjacent to recessed tooled joints.

3.4 CLEANING

- A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.5 PROTECTION

- A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

END OF SECTION 079200

SECTION 081113 - HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Standard and custom hollow metal doors and frames.
2. Steel sidelight, borrowed lite and transom frames.
3. Windstorm Rated hollow metal doors and frames.
4. Louvers installed in hollow metal doors.
5. Light frames and glazing installed in hollow metal doors.

B. Related Sections:

1. Division 04 Section "Unit Masonry" for embedding anchors for hollow metal work into masonry construction.
2. Division 08 Section "Flush Wood Doors".
3. Division 08 Section "Glazing" for glass view panels in hollow metal doors".
4. Division 08 Section "Door Hardware".
5. Division 09 Sections "Exterior Painting" and "Interior Painting" for field painting hollow metal doors and frames.
6. Division 09 Sections "Non-Structural Metal Framing".
7. Division 09 Sections "Gypsum Board".

C. Codes and References: Comply with the version year adopted by the Authority Having Jurisdiction.

1. ANSI/SDI A250.8 - Recommended Specifications for Standard Steel Doors and Frames.
2. ANSI/SDI A250.4 - Test Procedure and Acceptance Criteria for Physical Endurance for Steel Doors, Frames, Frames Anchors and Hardware Reinforcing.
3. ANSI/SDI A250.6 - Recommended Practice for Hardware Reinforcing on Standard Steel Doors and Frames.
4. ANSI/SDI A250.10 - Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames.
5. ANSI/SDI A250.11 - Recommended Erection Instructions for Steel Frames.
6. ASTM A1008 - Standard Specification for Steel Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
7. ASTM A653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
8. ASTM A924 - Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.

9. ASTM C 1363 - Standard Test Method for Thermal Performance of Building Assemblies by Means of a Hot Box Apparatus.
10. ANSI/BHMA A156.115 - Hardware Preparation in Steel Doors and Frames.
11. ANSI/SDI 122 - Installation and Troubleshooting Guide for Standard Steel Doors and Frames.
12. ANSI/NFPA 80 - Standard for Fire Doors and Fire Windows; National Fire Protection Association.
13. ANSI/NFPA 105: Standard for the Installation of Smoke Door Assemblies.
14. NFPA 252 - Standard Methods of Fire Tests of Door Assemblies; National Fire Protection Association.
15. UL 10C - Positive Pressure Fire Tests of Door Assemblies.
16. UL 1784 - Standard for Air Leakage Tests of Door Assemblies.
17. IBC 2012.
18. ASCE7-10, Minimum Design Loads for Buildings and Other Structures.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, core descriptions, hardware reinforcements, profiles, anchors, fire-resistance rating, and finishes.
- B. Door hardware supplier is to furnish templates, template reference number and/or physical hardware to the steel door and frame supplier in order to prepare the doors and frames to receive the finish hardware items.
- C. Shop Drawings: Include the following:
 1. Elevations of each door design.
 2. Details of doors, including vertical and horizontal edge details and metal thicknesses.
 3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
 4. Locations of reinforcement and preparations for hardware.
 5. Details of anchorages, joints, field splices, and connections.
 6. Details of accessories.
 7. Details of moldings, removable stops, and glazing.
- D. Samples for Verification:
 1. Samples are only required by request of the Design Professional and for manufacturers that are not current members of the Steel Door Institute.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain hollow metal doors and frames through one source from a single manufacturer wherever possible.
- B. Quality Standard: In addition to requirements specified, comply with ANSI/SDI A250.8, latest edition, "Recommended Specifications for Standard Steel Doors and Frames".

- C. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 (neutral pressure at 40" above sill) or UL 10C.
 - 1. Oversize Fire-Rated Door Assemblies Construction: For units exceeding sizes of tested assemblies, attach construction label certifying doors are built to standard construction requirements for tested and labeled fire rated door assemblies except for size.
 - 2. Temperature-Rise Limit: Where indicated and at vertical exit enclosures (stairwell openings) and exit passageways, provide doors that have a maximum transmitted temperature end point of not more than 450 deg F (250 deg C) above ambient after 30 minutes of standard fire-test exposure.
 - 3. Smoke Control Door Assemblies: Comply with NFPA 105.
 - a. Smoke "S" Label: Doors to bear "S" label, and include smoke and draft control gasketing applied to frame and on meeting stiles of pair doors.
- D. Fire-Rated, Borrowed-Light Frame Assemblies: Assemblies complying with NFPA 80 that are listed and labeled, by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 257. Provide labeled glazing material.
- E. Pre-Submittal Conference: Conduct conference in compliance with requirements in Division 01 Section "Project Meetings" with attendance by representatives of Supplier, Installer, and Contractor to review proper methods and procedures for installing hollow metal doors and frames and to verify installation of electrical knockout boxes and conduit at frames with electrified or access control hardware.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver hollow metal work palletized, wrapped, or crated to provide protection during transit and Project site storage. Do not use non-vented plastic.
- B. Deliver welded frames with one removable shipping spreader bars across bottom of frames, tack welded to jambs and mullions. The shipping spreader shall be removed prior to setting the frame.
- C. Store hollow metal work under cover at Project site. Place in stacks of five units maximum in a vertical position with heads up, spaced by blocking, on minimum 4-inch high wood blocking. Do not store in a manner that traps excess humidity.
 - 1. Provide minimum 1/4-inch space between each stacked door to permit air circulation. Door and frames to be stacked in a vertical upright position.

1.6 COORDINATION

- A. Coordinate installation of anchorages for hollow metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.

1.7 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace doors that fail in materials or workmanship within specified warranty period.
- B. Warranty includes installation and finishing that may be required due to repair or replacement of defective doors.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. CECO Door Products.
 - 2. Curries Company.
 - 3. Steelcraft.

2.2 MATERIALS

- A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.
- B. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with minimum G60 (Z180) or A60 (ZF180) metallic coating.
- C. Frame Anchors: ASTM A 653/A 653M, Commercial Steel (CS), Commercial Steel (CS), Type B; with minimum G60 (Z180) or A60 (ZF180) metallic coating.

2.3 STANDARD HOLLOW METAL DOORS

- A. General: Provide 1-3/4 inch doors of design indicated, not less than thickness indicated; fabricated with smooth surfaces, without visible joints or seams on exposed faces unless otherwise indicated. Comply with ANSI/SDI A250.8.
- B. Exterior Doors: Face sheets fabricated of commercial quality hot-dipped zinc coated steel that complies with ASTM A 653/A 653M, Coating Designation A60. Provide doors complying with requirements indicated below by referencing ANSI/SDI A250.8 for Level 3 and Model 2 Seamless and ANSI/SDI A250.4 for physical performance level:
 - 1. Design: Flush panel, seamless edges.
 - 2. Core Construction: Manufacturer's standard polystyrene. Where indicated, provide doors fabricated as thermal-rated assemblies with a minimum R-value of 2.7.
 - 3. Top and Bottom Edges: Reinforce tops and bottoms of doors with a continuous steel channel not less than 16 gauge, extending the full width of the door and welded to the face sheet. Doors with an inverted top channel to include a steel closure channel, screw attached, with the web of the channel flush with the face sheets of the door. Plastic or composite channel fillers are not acceptable.

4. Hinge Reinforcement: Minimum 7 gauge (3/16") plate 1-1/4" x 9" or minimum 14 gauge continuous channel with pierced holes, drilled and tapped.
5. Hardware Reinforcements: Fabricate according to ANSI/SDI A250.6 with reinforcing plates from same material as door face sheets.
6. Door Gauge: 16 gauge cold rolled steel, A60 galvanized, seamless.
7. Windload: Provide doors meeting the manufacturer's assembly testing for the buildings static design pressures for exterior components and cladding. These are minimum gauge requirements. However, this does not relieve the supplier from complying with the structural requirements with respect to the buildings static design pressures. Refer to the structural specifications and drawings for those requirements and provide the required gauge and door construction to meet those requirements, and provide the required gauge and door construction to meet those requirements.
8. Door Gauge: 16 gauge A60 galvanealed, seamless.

C. Interior Doors: Face sheets fabricated of commercial quality cold rolled steel that complies with ASTM A 1008/A 1008M. Provide doors complying with requirements indicated below by referencing ANSI/SDI A250.8 for Level 2 and Model 2 Seamless and ANSI/SDI A250.4 for physical performance level:

1. Design: Flush panel, seamless edges.
2. Core Construction: Manufacturer's standard kraft-paper honeycomb, or one-piece polystyrene core, securely bonded to both faces.
3. Top and Bottom Edges: Reinforce tops and bottoms of doors with a continuous steel channel not less than 16 gauge, extending the full width of the door and welded to the face sheet.
4. Hinge Reinforcement: Minimum 7 gauge (3/16") plate 1-1/4" x 9" or minimum 14 gauge continuous channel with pierced holes, drilled and tapped.
5. Hardware Reinforcements: Fabricate according to ANSI/SDI A250.6 with reinforcing plates from same material as door face sheets.
6. Door Gauge: 18 gauge cold rolled steel, seamless.

D. Manufacturers Basis of Design:

1. Curries Company 707 Series.
2. Curries Company Temperature Rise: 727, for hollow metal stair enclosure doors.

2.4 STANDARD HOLLOW METAL FRAMES

A. General: Comply with ANSI/SDI A250.8 and with details indicated for type and profile.

B. Exterior Frames: Fabricated of hot-dipped zinc coated steel that complies with ASTM A 653/A 653M, Coating Designation A60.

1. Fabricate frames with die mitered interlocked corners.
2. Frames shall be continuously welded on face, finished smooth with no visible seam unless otherwise indicated.
3. All frames shall be 14 gauge cold rolled steel.
4. Exterior frames shall be a minimum A60 galvanized.

5. Windload: Provide frames meeting the manufacturer's assembly testing for the buildings static design pressures for exterior components and cladding. These are minimum gauge requirements. However, this does not relieve the supplier from complying with the structural requirements with respect to the buildings static design pressures. Refer to the structural specifications and drawings for those requirements.
6. Manufacturers Basis of Design:
 - a. Curries Company M Series.

C. Interior Frames: Fabricated from cold-rolled steel sheet that complies with ASTM A 1008/A 1008M.

1. Fabricate frames with die mitered interlocked corners.
2. Frames shall be continuously welded on face, finished smooth with no visible seam unless otherwise indicated.
3. Frames for Steel Doors: Minimum 16 gauge (0.053-inch -1.3-mm) thick steel sheet.
4. Frames for openings up to 48 inches in width: Minimum 16 gauge (0.053-inch -1.3-mm) thick steel sheet.]
5. Frames for Wood Doors: Minimum 16 gauge (0.053-inch-1.3-mm-) thick steel sheet.
6. Frames for Borrowed Lights: Minimum 16 gauge (0.053-inch-1.3-mm-) thick steel sheet.
7. Manufacturers Basis of Design:
 - a. Curries Company M Series (Masonry Profile).

D. Fire rated frames: Fabricate frames in accordance with NFPA 80, listed and labeled by a qualified testing agency, for fire-protection ratings indicated.

E. Hardware Reinforcement: Fabricate according to ANSI/SDI A250.6 Table 4 with reinforcement plates from same material as frames.

2.5 FRAME ANCHORS

A. Jamb Anchors:

1. Masonry Type: T-shaped anchors to suit frame size, formed from A60 metallic coated material, not less than 0.042 inch thick, with corrugated or perforated straps not less than 2 inches wide by 10 inches long; or wire anchors not less than 0.177 inch thick.
2. Stud Wall Type: Designed to engage stud and not less than 0.042 inch thick.
3. Windstorm Opening Anchors: Types as tested and required for indicated wall types to meet specified wind load design criteria.

B. Floor Anchors: Floor anchors to be provided at each jamb, formed from A60 metallic coated material, not less than 0.042 inches thick.

C. Mortar Guards: Formed from same material as frames, not less than 0.016 inches thick.

2.6 LOUVERS

A. Metal Louvers: Door manufacturer's standard metal louvers unless otherwise indicated.

1. Blade Type: Vision proof inverted V or inverted Y.
 2. Metal and Finish: Galvanized steel, 0.040 inch thick, factory primed for paint finish with baked enamel or powder coated finish. Match pre-finished door paint color where applicable.
 3. Windstorm Rated: Provide exterior louvers, where required, to conform to the required static design pressures for the building.
- B. Louvers for Fire Rated Doors: Metal louvers with fusible link and closing device, listed and labeled for use in doors with fire protection rating of 1-1/2 hours and less.
1. Manufacturers: Subject to compliance with requirements, provide door manufacturers standard louver to meet rating indicated.
 2. Metal and Finish: Galvanized steel, 0.040 inch thick, factory primed for paint finish with baked enamel or powder coated finish. Match pre-finished door paint color where applicable.

2.7 LIGHT OPENINGS AND GLAZING

- A. Stops and Moldings: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with butted or mitered hairline joints at fabricator's shop. Fixed and removable stops to allow multiple glazed lites each to be removed independently. Coordinate frame rabbet widths between fixed and removable stops with the type of glazing and installation indicated.
- B. Moldings for Glazed Lites in Doors and Loose Stops for Glazed Lites in Frames: Minimum 20 gauge thick, fabricated from same material as door face sheet in which they are installed. Provide pockets in Lites suitable for the glass thickness specified in Division 08 Section "Glazing".
- C. Fixed Frame Moldings: Formed integral with hollow metal frames, a minimum of 5/8 inch (16 mm) high unless otherwise indicated. Provide fixed frame moldings and stops on outside of exterior and on secure side of interior doors and frames
- D. Preformed Metal Frames for Light Openings: Manufacturer's standard frame formed of 0.048-inch-thick, cold rolled steel sheet; with baked enamel or powder coated finish; and approved for use in doors of fire protection rating indicated. Match pre-finished door paint color where applicable.

2.8 ACCESSORIES

- A. Mullions and Transom Bars: Join to adjacent members by welding or rigid mechanical anchors.
- B. Grout Guards: Formed from same material as frames, not less than 0.016 inches thick.

2.9 FABRICATION

- A. Fabricate hollow metal work to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for thickness of metal. Where practical, fit and assemble units in manufacturer's plant. When shipping limitations so dictate,

frames for large openings are to be fabricated in sections for splicing or splining in the field by others.

B. Tolerances: Fabricate hollow metal work to tolerances indicated in ANSI/SDI A250.8.

C. Hollow Metal Doors:

1. Exterior Doors: Provide optional weep-hole openings in bottom of exterior doors to permit moisture to escape where specified.
2. Glazed Lites: Factory cut openings in doors with applied trim or kits to fit.
3. Astragals: Provide overlapping astragals as noted in door hardware sets in Division 08 Section "Door Hardware" on one leaf of pairs of doors where required by NFPA 80 for fire-performance rating or where indicated. Extend minimum 3/4 inch beyond edge of door on which astragal is mounted.
4. Continuous Hinge Reinforcement: Provide welded continuous 12 gauge strap for continuous hinges specified in hardware sets in Division 08 Section "Door Hardware".

D. Hollow Metal Frames:

1. Shipping Limitations: Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.
2. Welded Frames: Weld flush face joints continuously; grind, fill, dress, and make smooth, flush, and invisible.
 - a. Welded frames are to be provided with one steel spreader temporarily attached to the bottom of both jambs to serve as a brace during shipping and handling. Spreader bars are for bracing only and are not to be used as a setting spreader to size the frame opening. The shipping spreader must be removed prior to setting the frame.
3. Sidelight and Transom Bar Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by butt welding.
4. High Frequency Hinge Reinforcement: Provide high frequency hinge reinforcements at door openings 48-inches and wider with mortise butt type hinges at top hinge locations.
5. Continuous Hinge Reinforcement: Provide welded continuous 12 gauge straps for continuous hinges specified in hardware sets in Division 08 Section "Door Hardware".
6. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated for removable stops, provide security screws at exterior locations.
7. Mortar Guards: Provide guard boxes at back of hardware mortises in frames at all hinges and strike preps regardless of grouting requirements.
8. Floor Anchors: Weld anchors to bottom of jambs and mullions with at least four spot welds per anchor.
9. Jamb Anchors: Provide number and spacing of anchors as follows:
 - a. Masonry Type: Locate anchors not more than 18 inches from top and bottom of frame. Space anchors not more than 32 inches o.c. and as follows:
 - 1) Two anchors per jamb up to 60 inches high.

- 2) Three anchors per jamb from 60 to 90 inches high.
 - 3) Four anchors per jamb from 90 to 120 inches high.
 - 4) Four anchors per jamb plus 1 additional anchor per jamb for each 24 inches or fraction thereof above 120 inches high.
- b. Stud Wall Type: Locate anchors not more than 18 inches from top and bottom of frame. Space anchors not more than 32 inches o.c. and as follows:
- 1) Three anchors per jamb up to 60 inches high.
 - 2) Four anchors per jamb from 60 to 90 inches high.
 - 3) Five anchors per jamb from 90 to 96 inches high.
 - 4) Five anchors per jamb plus 1 additional anchor per jamb for each 24 inches or fraction thereof above 96 inches high.
 - 5) Two anchors per head for frames above 42 inches wide and mounted in metal stud partitions.
10. Door Silencers: Except on weatherstripped or gasketed doors, drill stops to receive door silencers. Silencers to be supplied by frame manufacturer regardless if specified in Division 08 Section "Door Hardware".
- E. Hardware Preparation: Factory prepare hollow metal work to receive template mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to the Door Hardware Schedule and templates furnished as specified in Division 08 Section "Door Hardware."
1. Locate hardware as indicated, or if not indicated, according to ANSI/SDI A250.8.
 2. Reinforce doors and frames to receive non-template, mortised and surface mounted door hardware.
 3. Comply with applicable requirements in ANSI/SDI A250.6 and ANSI/DHI A115 Series specifications for preparation of hollow metal work for hardware.

2.10 STEEL FINISHES

- A. Prime Finishes: Doors and frames to be cleaned, and chemically treated to insure maximum finish paint adhesion. Surfaces of the door and frame exposed to view to receive a factory applied coat of rust inhibiting shop primer.
1. Shop Primer: Manufacturer's standard, fast-curing, lead and chromate free primer complying with ANSI/SDI A250.10 acceptance criteria; recommended by primer manufacturer for substrate; and compatible with substrate and field-applied coatings.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

- B. General Contractor to verify the accuracy of dimensions given to the steel door and frame manufacturer for existing openings or existing frames (strike height, hinge spacing, hinge back set, etc.).
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Remove welded in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces.
- B. Prior to installation, adjust and securely brace welded hollow metal frames for squareness, alignment, twist, and plumbness.
- C. Tolerances shall comply with SDI-117 "Manufacturing Tolerances Standard Steel Doors and Frames."
- D. Drill and tap doors and frames to receive non-template, mortised, and surface-mounted door hardware.

3.3 INSTALLATION

- A. General: Install hollow metal work plumb, rigid, properly aligned, and securely fastened in place; comply with Drawings and manufacturer's written instructions.
- B. Hollow Metal Frames: Install hollow metal frames of size and profile indicated. Comply with ANSI/SDI A250.11 and NFPA 80 at fire rated openings.
 - 1. Remove shipping spreaders from the frames. Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete and frames properly set and secured, remove temporary braces, leaving surfaces smooth and undamaged. Shim as necessary to comply with installation tolerances.
 - 2. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and secure with post-installed expansion anchors.
 - 3. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with mortar.
 - 4. Grout Requirements: Do not grout head of frames unless reinforcing has been installed in head of frame. Do not grout vertical or horizontal closed mullion members.
- C. Hollow Metal Doors: Fit hollow metal doors accurately in frames, within clearances specified below. Shim as necessary.
 - 1. Non-Fire-Rated Standard Steel Doors:
 - a. Jamb and Head: 1/8 inch plus or minus 1/16 inch.
 - b. Between Edges of Pairs of Doors: 1/8 inch plus or minus 1/16 inch.
 - c. Between Bottom of Door and Top of Threshold: Maximum 3/8 inch.

- d. Between Bottom of Door and Top of Finish Floor (No Threshold): Maximum 3/4 inch.
- 2. Fire-Rated Doors: Install doors with clearances according to NFPA 80.
- D. Field Glazing: Comply with installation requirements in Division 08 Section "Glazing" and with hollow metal manufacturer's written instructions.

3.4 ADJUSTING AND CLEANING

- A. Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including hollow metal work that is warped, bowed, or otherwise unacceptable.
- B. Remove grout and other bonding material from hollow metal work immediately after installation.
- C. Prime-Coat and Painted Finish Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat, or painted finishes, and apply touchup of compatible air drying, rust-inhibitive primer, zinc rich primer (exterior and galvanized openings) or finish paint.

END OF SECTION 081113

SECTION 081416 - FLUSH WOOD DOORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

1. Solid core doors with wood veneer.
2. Factory finishing wood doors.
3. Factory fitting wood doors to frames and factory machining for hardware.
4. Louvers installed in flush wood doors.
5. Light frames and glazing installed in wood doors.

- B. Related Sections:

1. Division 08 Section "Hollow Metal Doors and Frames" for wood doors in steel frames.
2. Division 08 Section "Glazing" for glass view panels in wood doors.
3. Division 08 Section "Door Hardware" for door hardware for flush wood doors and wood frames.

- C. Standards and References: Comply with the version year adopted by the Authority Having Jurisdiction.

1. ANSI A208.1 – Wood Particleboard.
2. Intertek Testing Service (ITS Warnock Hersey) - Certification Listings for Fire Doors.
3. NFPA 80 - Standard for Fire Doors and Fire Windows; National Fire Protection Association.
4. NFPA 252 - Standard Methods of Fire Tests of Door Assemblies; National Fire Protection Association.
5. UL 10C - Positive Pressure Fire Tests of Door Assemblies; UL 1784 - Standard for Air Leakage Tests of Door Assemblies.
6. Window and Door Manufacturers Association - WDMA I.S.1-A Architectural Wood Flush Doors.

1.3 SUBMITTALS

- A. Product Data: For each type of door indicated. Include details of core and edge construction, louvers, trim for openings, and WDMA I.S.1-A or AWS classifications. Include factory finishing specifications.

- B. Door hardware supplier is to furnish templates, template reference number and/or physical hardware to the wood door supplier in order to prepare the doors and frames to receive the finish hardware items.
- C. Shop Drawings: Indicate location, size, and hand of each door; elevation of each kind of door; construction details not covered in Product Data; location and extent of hardware blocking; and other pertinent data.
 - 1. Indicate dimensions and locations of mortises and holes for hardware.
 - 2. Indicate dimensions and locations of cutouts.
 - 3. Indicate requirements for veneer matching.
 - 4. Indicate doors to be factory finished and finish requirements.
 - 5. Indicate fire protection ratings for fire rated doors.
- D. Samples for Initial Selection: For factory finished doors.
 - 1. Factory finishes applied to actual door face materials, approximately 8 by 10 inches, for each material and finish. For each wood species and transparent finish, provide set of three samples showing typical range of color and grain to be expected in the finished work.
 - 2. Corner sections of doors, 8 by 10 inches, with door faces and edges representing actual materials to be used.
 - a. Provide samples for each species of veneer and solid lumber required.
 - b. Finish veneer faced door samples with same materials proposed for factory finished doors.
 - 3. Frames for light openings, 6 inches long, for each material, type, and finish required.
- E. Warranty: Sample of special warranties.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain flush wood doors through one source from a single manufacturer wherever possible.
- B. Quality Standard: In addition to requirements specified, comply with WDMA I.S.1-A, latest edition, "Industry Standard for Architectural Wood Flush Doors".
- C. Fire Rated Wood Doors: Doors complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing at positive pressure according to NFPA 252 (neutral pressure at 40" above sill) or UL 10C (neutral pressure testing according to UL 10B where specified).
 - 1. Oversize Fire Rated Door Assemblies: For units exceeding sizes of tested assemblies provide manufacturer's construction label, indicating compliance to independent 3rd party certification agency's procedure, except for size.

2. Temperature Rise Limit: Where indicated and at vertical exit enclosures (stairwell openings) and exit passageways, provide doors that have a maximum transmitted temperature end point of not more than 450 deg F (250 deg C) above ambient after 30 minutes of standard fire test exposure.
 3. Smoke Control Door Assemblies: Comply with NFPA 105.
 - 1) Smoke "S" Label: Doors to bear "S" label, and include smoke and draft control gasketing applied to frame and on meeting stiles of pair doors.
 4. Blocking: Indicate size and location of blocking in 45, 60 and 90 minute mineral core doors.
- D. Pre-Submittal Conference: Conduct conference in compliance with requirements in Division 01 Section "Project Meetings" with attendance by representatives of Supplier, Installer, and Contractor to review proper methods and procedures for receiving, handling, and installing flush wood doors.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Comply with requirements of referenced standard and manufacturer's written instructions.
- B. Package pre-finished doors individually in plastic bags or cardboard cartons and wrap bundles of doors in plastic sheeting.
- C. Mark each door on top rail with opening number used on Shop Drawings.

1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install doors until spaces are enclosed and weather tight, wet work in spaces is complete and dry, and HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.7 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace doors that fail in materials or workmanship within specified warranty period.
 1. Failures include, but are not limited to, the following:
 - a. Warping (bow, cup, or twist) more than 1/4 inch in a 42-by-84-inch section.
 - b. Telegraphing of core construction in wood face veneers exceeding 0.01 inch in a 3-inch span.
 - c. Telegraphing of core construction and delaminating of face in decorative laminate-faced doors.

2. Warranty includes installation and finishing that may be required due to repair or replacement of defective doors.
3. Warranty Period for Solid Core Interior Doors: Life of installation according to manufacturer's written warranty.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with the requirements, provide products by one of the following:
 1. Algoma Hardwoods, Inc.
 2. Graham Wood Doors; an Assa Abloy Group company.
 3. Marshfield Door Systems, Inc.; a Division of Masonite Architectural Door Systems.

2.2 DOOR CONSTRUCTION – GENERAL

- A. WDMA I.S.1-A Performance Grade: Heavy Duty; Aesthetic Grade: Premium.
- B. Fire Rated Doors: Provide construction and core as needed to provide fire ratings indicated.
 1. Category A Edge Construction: Provide fire rated door edge construction with intumescent seals concealed by outer stile (Category A) at 45, 60, and 90 minute rated doors. Comply with specified requirements for exposed edges.
 2. Pairs: Provide fire retardant stiles that are listed and labeled for applications indicated without formed steel edges and astragals. Provide stiles with concealed intumescent seals. Comply with specified requirements for exposed edges.

2.3 CORE CONSTRUCTION

- A. Particleboard Core Doors:
 1. Particleboard: Wood fiber-based materials complying with ANSI A208.1 Particleboard standard, WDMA Performance Duty Level; Heavy Duty.
 2. Adhesive: Per requirements of WDMA I.S. 1A, C-6.
 3. Basis of Design:
 - a. Algoma: Novodor
 - b. Graham: GPD, PC5
 - c. Marshfield: DPC
- B. Mineral Core Doors:

1. Core: Non-combustible mineral product complying with requirements of referenced quality standard and testing and inspecting agency for fire protection rating indicated.
2. Edge Construction: At hinge stiles, provide laminated edge construction with improved screw holding capability and split resistance. Comply with specified requirements for exposed edges.
3. Basis of Design:
 - a. Graham GPD-FD.
 - b. Marshfield DFM.

C. Structural Composite Lumber Doors:

1. Where non rated door cutouts exceed 40% of the doors surface area, provide doors with a structural composite lumber core.

2.4 VENEERED DOORS FOR TRANSPARENT FINISH

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Graham: GPD
2. Marshfield: Signature Series
3. Algoma: Novodor

B. Interior Solid Core Doors:

1. Assembly of Veneer Leaves on Door Faces:
 - a. Match: Center Balanced Match.
 - b. Species: Plain Sliced Red Oak.
 - c. Grade: Grade A.
2. Pair and Set Match: Provide for doors hung in same opening or separated only by mullions.
3. Transom Match: Continuous match.
4. Vertical Edges: Matching same species as faces. Wood or composite material, one piece, laminated, or veneered. Minimum requirements per WDMA section P-1, Performance Standards for Architectural Wood Flush Doors.
5. Horizontal Edges: Solid wood or structural composite material meeting the minimum requirements per WDMA section P-1, Performance Standards for Architectural Wood Flush Doors
6. Construction: Five plies. Stiles and rails are bonded to core, then entire unit sanded before applying face veneers.
7. At doors over 40% of the face cut-out for lights and or louvers, furnish engineered composite lumber core.

2.5 LOUVERS

- A. Metal Louvers: Door manufacturer's standard metal louvers unless otherwise indicated.
 - 1. Blade Type: Vision proof inverted V or inverted Y.
 - 2. Metal and Finish: Galvanized steel, 0.040 inch thick, factory primed for paint finish with baked enamel or powder coated finish.
- B. Louvers for Fire Rated Doors: Metal louvers with fusible link and closing device, listed and labeled for use in doors with fire protection rating of 1-1/2 hours and less.
 - 1. Manufacturers: Subject to compliance with requirements, provide door manufacturers standard louver to meet rating indicated.
 - 2. Metal and Finish: Galvanized steel, 0.040 inch thick, factory primed for paint finish with baked enamel or powder coated finish.

2.6 LIGHT FRAMES AND GLAZING

- A. Wood Beads for Light Openings in non rated Wood Doors:
 - 1. Wood Species: Same species as door faces.
 - 2. Profile: Manufacturer's standard flush profile.
- B. Metal Frames for Light Openings in Fire Rated Doors 20-minute rating and greater: Manufacturer's standard frame formed of 0.048-inch-thick, cold rolled steel sheet; with baked enamel or powder coated finish; and approved for use in doors of fire protection rating indicated.
- C. Glazing: Comply with installation requirements in Division 08 Section "Glazing" and with the flush wood door manufacturer's written instructions.

2.7 FABRICATION

- A. Factory fit doors to suit frame opening sizes indicated. Comply with clearance requirements of referenced quality standard for fitting unless otherwise indicated.
 - 1. Comply with requirements in NFPA 80 for fire rated doors.
- B. Factory machine doors for hardware that is not surface applied. Comply with final hardware schedules, door frame Shop Drawings, DHI A115-W series standards, and hardware templates.
 - 1. Coordinate with hardware mortises in metal frames to verify dimensions and alignment before factory machining.
 - 2. Metal Astragals: Factory machine astragals and formed steel edges for hardware for pairs of fire rated doors.
- C. Transom and Side Panels: Fabricate matching panels with same construction, exposed surfaces, and finish as specified for associated doors. Finish bottom edges of transoms and top edges of rabbeted doors same as door stiles.

- D. Openings: Cut and trim openings through doors in factory.
 - 1. Light Openings:
 - a. Wood-Veneered Beads for Light Openings in Wood Doors: Provide manufacturer's standard wood beads unless otherwise indicated. Beads shall be of the same species specified for the door faces. Profile shall be flush rectangular beads.
 - b. Metal Frames for Light Openings in Fire-Rated Doors: Manufacturer's standard frame formed of 0.048 inch thick, cold rolled steel sheet; factory primed for paint finish; and approved for use in doors of fire-protection rating indicated.
 - 2. Glazing: Comply with applicable requirements in Division 08 Section "Glazing."
 - 3. Louvers: Factory install louvers in prepared openings.

2.8 FACTORY FINISHING

- A. General: Comply with referenced quality standard for factory finishing. Complete fabrication, including fitting doors for openings and machining for hardware that is not surface applied, before finishing.
 - 1. Finish faces, all four edges, edges of cutouts, and mortises. Stains and fillers may be omitted on top and bottom edges, edges of cutouts, and mortises.
- B. Transparent Finish: Provide a clear protective coating over the wood veneer allowing the natural color and grain of the selected wood species to provide the appearance specified. Stain is applied to the wood surface underneath the transparent finish to add color and design flexibility.
 - 1. Grade: Premium.
 - 2. Finish: Meet or exceed WDMA I.S. 1A TR6 Catalyzed Polyurethane finish performance requirements.
 - 3. Staining: As selected by Design Professional from manufacturer's full range.
 - 4. Sheen: Satin.
 - 5. Color: As selected from the manufacturers standard color offering.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine doors and installed door frames before hanging doors.
 - 1. Verify that frames comply with indicated requirements for type, size, location, and swing characteristics and have been installed with level heads and plumb jambs.
 - 2. Reject doors with defects.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Hardware: For installation, see Division 8 Section "Door Hardware."
- B. Installation Instructions: Install doors to comply with manufacturer's written instructions and the referenced quality standard, and as indicated.
 - 1. Install fire rated doors in corresponding fire rated frames according to NFPA 80.
- C. Factory Fitted Doors: Align in frames for uniform clearance at each edge.
- D. Factory Finished Doors: Restore finish before installation if fitting or machining is required at Project site.

3.3 ADJUSTING

- A. Operation: Re-hang or replace doors that do not swing or operate freely.
- B. Finished Doors: Replace doors that do not comply with requirements. Doors may be repaired or refinished if work complies with requirements and shows no evidence of repair or refinishing.

END OF SECTION 081416

SECTION 083323 - OVERHEAD COILING DOORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Non-Insulated Service Doors.
- B. Related Sections:
 - 1. Division 5 Section "Metal Fabrications" for miscellaneous steel supports.

1.3 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design overhead coiling doors, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Seismic Performance: Overhead coiling doors shall withstand the effects of earthquake motions determined according to SEI/ASCE 7 Insert requirement.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified.
 - 2. Seismic Component Importance Factor: 1.0.
- C. Operation Cycles: Provide overhead coiling door components and operators capable of operating for not less than number of cycles indicated for each door. One operation cycle is complete when a door is opened from the closed position to the fully open position and returned to the closed position.

1.4 SUBMITTALS

- A. Product Data: For each type and size of overhead coiling door and accessory. Include the following:
 - 1. Construction details, material descriptions, dimensions of individual components, profiles for slats, and finishes.
 - 2. Rated capacities, operating characteristics, electrical characteristics, and furnished accessories.

- B. Shop Drawings: For each installation and for special components not dimensioned or detailed in manufacturer's product data. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Include diagrams for power, signal, and control wiring.
- C. Samples for Initial Selection: Manufacturer's finish charts showing full range of colors and textures available for units with factory-applied finishes.
 - 1. Include similar Samples of accessories involving color selection.
- D. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below.
 - 1. Insulated and Non-insulated Curtain Slats: 12 inches long.
 - 2. Bottom Bar: 6 inches long.
 - 3. Guides: 6 inches long.
 - 4. Brackets: 6 inches square.
 - 5. Hood: 6 inches square.
- E. Delegated-Design Submittal: For overhead coiling doors indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - 1. Detail fabrication and assembly of seismic restraints.
 - 2. Summary of forces and loads on walls and jambs.
- F. Seismic Qualification Certificates: For overhead coiling doors, accessories, and components, from manufacturer.
- G. Maintenance Data: For overhead coiling doors to include in maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for both installation and maintenance of units required for this Project.
- B. Source Limitations: Obtain overhead coiling doors from single source from single manufacturer.

PART 2 - PRODUCTS

2.1 DOOR CURTAIN MATERIALS AND CONSTRUCTION

- A. Door Curtains: Fabricate overhead coiling-door curtain of interlocking metal slats, designed to withstand seismic loading indicated, in a continuous length for width of door without splices. Unless otherwise indicated, provide slats of thickness and mechanical properties recommended by door manufacturer for performance, size, and type of door indicated, and as follows:
 - 1. Aluminum Door Curtain Slats: ASTM B 209 sheet or ASTM B 221 extrusions, alloy and temper standard with manufacturer for type of use and finish indicated; thickness of 0.050 inch and as required to meet requirements.
 - 2. Metal Interior Curtain-Slat Facing: Match metal of exterior curtain-slat face.
 - 3. Gasket Seal: Provide insulated slats with manufacturer's standard interior-to-exterior thermal break or with continuous gaskets between slats.
- B. Endlocks for Service Doors: Manufacturer's standard locks on not less than alternate curtain slats for curtain alignment and resistance against lateral movement.
- C. Bottom Bar for Service Doors: Manufacturer's standard continuous channel or tubular shape, fabricated from manufacturer's standard hot-dip galvanized steel, stainless steel, or aluminum extrusions to match curtain slats and finish.
- D. Curtain Jamb Guides: Manufacturer's standard angles or channels and angles of same material and finish as curtain slats unless otherwise indicated, with sufficient depth and strength to retain curtain, to allow curtain to operate smoothly, and to withstand loading. Slot bolt holes for guide adjustment. Provide removable stops on guides to prevent overtravel of curtain.

2.2 HOOD

- A. General: Form sheet metal hood to entirely enclose coiled curtain and operating mechanism at opening head. Contour to fit end brackets to which hood is attached. Roll and reinforce top and bottom edges for stiffness. Form closed ends for surface-mounted hoods and fascia for any portion of between-jamb mounting that projects beyond wall face. Equip hood with intermediate support brackets as required to prevent sagging.
 - 1. Aluminum: 0.040-inch- thick aluminum sheet complying with ASTM B 209, of alloy and temper recommended by manufacturer and finisher for type of use and finish indicated.

2.3 LOCKING DEVICES

- A. Slide Bolt: Fabricate with side-locking bolts to engage through slots in tracks for locking by padlock, located on both left and right jamb sides, operable from coil side.

2.4 CURTAIN ACCESSORIES

- A. Push/Pull Handles: Equip each push-up-operated or emergency-operated door with lifting handles on each side of door, finished to match door.
 - 1. Provide pull-down straps or pole hooks for doors more than 84 inches high.
- B. Weatherseals: Equip each exterior door with weather-stripping gaskets fitted to entire perimeter of door for a weathertight installation, unless otherwise indicated.
 - 1. At door head, use 1/8-inch- thick, replaceable, continuous sheet secured to inside of hood.
 - 2. At door jambs, use replaceable, adjustable, continuous, flexible, 1/8-inch- thick seals of flexible vinyl, rubber, or neoprene.

2.5 COUNTERBALANCING MECHANISM

- A. General: Counterbalance doors by means of manufacturer's standard mechanism with an adjustable-tension, steel helical torsion spring mounted around a steel shaft and contained in a spring barrel connected to top of curtain with barrel rings. Use grease-sealed bearings or self-lubricating graphite bearings for rotating members.
- B. Counterbalance Barrel: Fabricate spring barrel of manufacturer's standard hot-formed, structural-quality, welded or seamless carbon-steel pipe, of sufficient diameter and wall thickness to support rolled-up curtain without distortion of slats and to limit barrel deflection to not more than 0.03 in./ft. of span under full load.
- C. Spring Balance: One or more oil-tempered, heat-treated steel helical torsion springs. Size springs to counterbalance weight of curtain, with uniform adjustment accessible from outside barrel. Secure ends of springs to barrel and shaft with cast-steel barrel plugs.
- D. Torsion Rod for Counterbalance Shaft: Fabricate of manufacturer's standard cold-rolled steel, sized to hold fixed spring ends and carry torsional load.
- E. Brackets: Manufacturer's standard mounting brackets of either cast iron or cold-rolled steel plate.

2.6 MANUAL DOOR OPERATORS

- A. Equip counter doors with manufacturer's recommended manual door operator unless another type of door operator is indicated.
- B. Push-up Door Operation: Design counterbalance mechanism so required lift or pull for door operation does not exceed 25 lbf.

2.7 DOOR ASSEMBLY

- A. Overhead coiling door formed with curtain of interlocking metal slats.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. ACME Rolling Doors.
- b. Alpine Overhead Doors, Inc.
- c. AlumaTek, Inc.
- d. C.H.I. Overhead Doors.
- e. City-Gates.
- f. Cookson Company.
- g. Cornell Iron Works, Inc.
- h. Dynamic Closures Corp.
- i. Lawrence Roll-Up Doors, Inc.
- j. Mahon Door Corporation.
- k. McKeon Rolling Steel Door Company, Inc.
- l. Metro Door.
- m. Overhead Door Corporation.
- n. QMI Security Solutions.
- o. Raynor.
- p. Southwestern Steel Rolling Door Co.
- q. Wayne-Dalton Corp.
- r. Windsor Door.

B. Operation Cycles: Not less than 10,000.

C. Door Curtain Material: Aluminum.

D. Door Curtain Slats: Flat profile slats of 2-5/8-inch center-to-center height.

E. Curtain Jamb Guides: Aluminum with exposed finish matching curtain slats. Provide continuous integral wear strips to prevent metal-to-metal contact and to minimize operational noise.

F. Hood: Aluminum.

1. Shape: Round.
2. Mounting: Face of wall.

G. Locking Devices: Equip door with slide bolt for padlock.

H. Door Finish:

1. Baked-Enamel or Powder-Coated Finish: Color as selected by Design Professional from manufacturer's full range.
2. Interior Curtain-Slat Facing: Match finish of exterior curtain-slat face.

2.8 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.9 ALUMINUM FINISHES

- A. Baked-Enamel or Powder-Coat Finish: AAMA 2603. Comply with coating manufacturer's written instructions for cleaning, conversion coating, application, and baking.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates areas and conditions, with Installer present, for compliance with requirements for substrate construction and other conditions affecting performance of the Work.
- B. Examine locations of electrical connections.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install overhead coiling doors and operating equipment complete with necessary hardware, anchors, inserts, hangers, and equipment supports; according to manufacturer's written instructions and as specified.
- B. Install overhead coiling doors, hoods, and operators at the mounting locations indicated for each door.
- C. Accessibility: Install overhead coiling doors, switches, and controls along accessible routes in compliance with regulatory requirements for accessibility.

3.3 ADJUSTING

- A. Adjust hardware and moving parts to function smoothly so that doors operate easily, free of warp, twist, or distortion.
- B. Lubricate bearings and sliding parts as recommended by manufacturer.
- C. Adjust seals to provide weathertight fit around entire perimeter.

3.4 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain overhead coiling doors.

END OF SECTION 083323

SECTION 084113 - ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Coordinate with section 087100 "Finish Hardware" in all aspects.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Exterior aluminum-framed, storefront doors and windows.
 - a. Glazing is retained mechanically with gaskets on four sides.
 - b. Framing system is thermally broken.
- B. Related Sections include the following:
 - 1. Division 7 Section "Building Insulation" for insulation materials field installed with aluminum-framed systems.
 - 2. Division 7 Section "Joint Sealants" for installation of joint sealants installed with aluminum-framed systems and for sealants to the extent not specified in this Section.
 - 3. Division 8 Section "Door Hardware" for hardware to the extent not specified in this Section.
 - 4. Division 8 Section "Glazing" for glazing requirements to the extent not specified in this Section.
 - 5. Divisions 26 and 27 for access-controlled openings.

1.3 PERFORMANCE REQUIREMENTS

- A. General: Provide aluminum-framed systems, including anchorage, capable of withstanding, without failure, the effects of the following:
 - 1. Structural loads.
 - 2. Thermal movements.
 - 3. Movements of supporting structure indicated on Drawings including, but not limited to, story drift and deflection from uniformly distributed and concentrated live loads.
 - 4. Dimensional tolerances of building frame and other adjacent construction.
 - 5. Failure includes the following:
 - a. Deflection exceeding specified limits.
 - b. Thermal stresses transferred to building structure.

- c. Framing members transferring stresses, including those caused by thermal and structural movements, to glazing.
 - d. Glazing-to-glazing contact.
 - e. Noise or vibration created by wind and thermal and structural movements.
 - f. Loosening or weakening of fasteners, attachments, and other components.
 - g. Sealant failure.
 - h. Failure of operating units to function properly.
- B. Structural Sealant: Capable of withstanding tensile and shear stresses imposed by aluminum-framed systems without failing adhesively or cohesively. Provide sealant that fails cohesively before sealant releases from substrate when tested for adhesive compatibility with each substrate and joint condition required.
- 1. Adhesive failure occurs when sealant pulls away from substrate cleanly, leaving no sealant material behind.
 - 2. Cohesive failure occurs when sealant breaks or tears within itself but does not separate from each substrate because sealant-to-substrate bond strength exceeds sealant's internal strength.
- C. Structural-Sealant Joints: Designed to produce tensile or shear stress in structural-sealant joints of less than 20 psi.
- D. Deflection of Framing Members:
- 1. Deflection Normal to Wall Plane: Limited to 1/175 of clear span for spans up to 13 feet 6 inches and to 1/240 of clear span plus 1/4 inch restricts edge deflection of individual glazing lites to 3/4 inch, whichever is less.
 - 2. Deflection Parallel to Glazing Plane: Limited to 1/360 of clear span or 1/8 inch, whichever is smaller.
- E. Structural-Test Performance: Provide aluminum-framed systems tested according to ASTM E 330 as follows:
- 1. When tested at positive and negative wind-load design pressures, systems do not evidence deflection exceeding specified limits.
- F. Thermal Movements: Provide aluminum-framed systems that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
- 1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.
 - 2. Test Performance: No buckling; stress on glass; sealant failure; excess stress on framing, anchors, and fasteners; or reduction of performance when tested according to AAMA 501.5.
- G. Air Infiltration: Provide aluminum-framed systems with maximum air leakage through fixed glazing and framing areas of 0.06 cfm/sq. ft. of fixed wall area when tested according to ASTM E 283 at a minimum static-air-pressure difference of 1.57 lbf/sq. ft. Water Penetration Under Static Pressure: Provide aluminum-framed systems that do not evidence water penetration through fixed glazing and framing areas when tested according to ASTM E 331 at a minimum static-air-pressure difference of 20 percent of positive wind-load design pressure, but not less than 6.24 lbf/sq. ft.

- H. Water Penetration Under Dynamic Pressure: Provide aluminum-framed systems that do not evidence water leakage through fixed glazing and framing areas when tested according to AAMA 501.1 under dynamic pressure equal to 20 percent of positive wind-load design pressure, but not less than 6.24 lbf/sq. ft. In paragraph below, insert condensation-resistance requirements for venting windows or doors if required.
- I. Condensation Resistance: Provide aluminum-framed systems with fixed glazing and framing areas having condensation-resistance factor (CRF) of not less than 48 when tested according to AAMA 1503.
- J. Average Thermal Conductance: Provide aluminum-framed systems with fixed glazing and framing areas having average U-factor of not more than 0.51 Btu/sq. ft. x h x deg F when tested according to AAMA 1503.

1.4 SUBMITTALS

- A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of product indicated.
- B. Shop Drawings: For aluminum-framed systems. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - 2. Include details of provisions for system expansion and contraction and for draining moisture occurring within the system to the exterior.
 - 3. For entrances, include hardware schedule and indicate operating hardware types, functions, quantities, and locations.
 - 4. All frames and doors requiring electrical raceways shall have elevation drawings provided showing the conductor path. It shall also show the required conductor counts for each run. A frame sample showing how this is achieved is required.
- C. Samples for Initial Selection: For units with factory-applied color finishes.
- D. Samples for Verification: For each type of exposed finish required, in manufacturer's standard sizes.
- E. Fabrication Sample: Of each vertical-to-horizontal intersection of systems, made from 12-inch lengths of full-size components and showing details of the following:
 - 1. Joinery.
 - 2. Anchorage.
 - 3. Expansion provisions.
 - 4. Glazing.
 - 5. Flashing and drainage.
 - 6. Wiring.

- F. Welding certificates.
- G. Certification demonstrating that the hardware installer is a factory authorized “Assa Abloy Certified Integrator.”
- H. Maintenance Data: For aluminum-framed systems to include in maintenance manuals.
- I. Warranties: Special warranties specified in this Section.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Capable of assuming engineering responsibility and performing work of this Section and who is acceptable to manufacturer.
- B. Product Options: Information on Drawings and in Specifications establishes requirements for systems' aesthetic effects and performance characteristics. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction. Performance characteristics are indicated by criteria subject to verification by one or more methods including preconstruction testing, field testing, and in-service performance.
 - 1. Do not modify intended aesthetic effects, as judged solely by Design Professional, except with Design Professional's approval. If modifications are proposed, submit comprehensive explanatory data to Design Professional for review.
- C. Accessible Entrances: Comply with Georgia Accessibility Code.
- D. Welding: Qualify procedures and personnel according to AWS D1.2, "Structural Welding Code--Aluminum."
- E. Structural-Sealant Glazing: Comply with recommendations in ASTM C 1401, "Guide for Structural Sealant Glazing."
- F. Structural-Sealant Joints: Design reviewed and approved by structural-sealant manufacturer.
- G. “ASSA Abloy Certified Integrator” credentials.

1.6 PROJECT CONDITIONS

- A. Field Measurements: Verify actual locations of structural supports for aluminum-framed systems by field measurements before fabrication and indicate measurements on Shop Drawings.
 - 1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating aluminum-framed systems without field measurements. Coordinate construction to ensure that actual dimensions correspond to established dimensions.

1.7 WARRANTY

- A. Special Assembly Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of aluminum-framed systems that do not comply with requirements or that deteriorate as defined in this Section within specified warranty period.
1. Failures include, but are not limited to, the following:
 - a. Structural failures including, but not limited to, excessive deflection.
 - b. Noise or vibration caused by thermal movements.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 - d. Adhesive or cohesive sealant failures.
 - e. Water leakage through fixed glazing and framing areas.
 - f. Failure of operating components to function properly.
 2. Warranty Period: 5 years from date of Substantial Completion.
- B. Special Finish Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components on which finishes fail within specified warranty period. Warranty does not include normal weathering.
1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Kawneer.
 2. Old Castle.
 3. YKK AP America Inc.
 - a. Basis of Design: YES 45 TU
 4. Tubelite.

2.2 MATERIALS

- A. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
1. Sheet and Plate: ASTM B 209.
 2. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221 Extruded Structural Pipe and Tubes: ASTM B 429.
 3. Structural Profiles: ASTM B 308/B 308M.
 4. Welding Rods and Bare Electrodes: AWS A5.10/A5.10M.

- B. Steel Reinforcement: With manufacturer's standard corrosion-resistant primer complying with SSPC-PS Guide No. 12.00 applied immediately after surface preparation and pretreatment. Select surface preparation methods according to recommendations in SSPC-SP COM and prepare surfaces according to applicable SSPC standard.
 - 1. Structural Shapes, Plates, and Bars: ASTM A 36/A 36M.
 - 2. Cold-Rolled Sheet and Strip: ASTM A 1008/A 1008M.
 - 3. Hot-Rolled Sheet and Strip: ASTM A 1011/A 1011M.

2.3 FRAMING SYSTEMS

- A. Framing Members: Manufacturer's standard extruded-aluminum framing members of thickness required and reinforced as required to support imposed loads.
- B. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with non-staining, nonferrous shims for aligning system components.
- C. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, non-staining, non-bleeding fasteners and accessories compatible with adjacent materials.
 - 1. Where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration, use self-locking devices.
 - 2. Reinforce members as required to receive fastener threads.
- D. Flashing: Manufacturer's standard corrosion-resistant, non-staining, non-bleeding flashing compatible with adjacent materials. Form exposed flashing from sheet aluminum finished to match framing and of sufficient thickness to maintain a flat appearance without visible deflection.
- E. Framing System Gaskets and Sealants: Manufacturer's standard recommended by manufacturer for joint type.
- F. Provide Manufacturer's flat filler pieces at head and jamb locations.

2.4 GLAZING SYSTEMS

- A. Glazing: As specified in Division 8 Section "Glazing."
- B. Glazing Gaskets: Manufacturer's standard compression types, replaceable, molded or extruded, that maintain uniform pressure and watertight seal.
- C. Spacers and Setting Blocks: Manufacturer's standard elastomeric types.
- D. Bond-Breaker Tape: Manufacturer's standard TFE-fluorocarbon or polyethylene material to which sealants will not develop adhesion.
- E. Glazing Sealants: For structural-sealant-glazed systems, as recommended by manufacturer for joint type and as follows:

1. Structural Sealant: ASTM C 1184, neutral-curing silicone formulation compatible with system components with which it comes in contact, specifically formulated and tested for use as structural sealant, and approved by structural-sealant manufacturer for use in aluminum-framed systems indicated.
 - a. Color: As selected by Design Professional from manufacturer's full range of colors.
2. Weatherseal Sealant: ASTM C 920 for Type S, Grade NS, Class 25, Uses NT, G, A, and O; neutral-curing silicone formulation compatible with structural sealant and other system components with which it comes in contact; and recommended by structural- and weatherseal-sealant and aluminum-framed system manufacturers for this use.
 - a. Color: Matching structural sealant.

2.5 DOORS

- A. Doors: Manufacturer's standard glazed doors, for manual swing operation, heavy duty, high traffic type, to match Basis of Design system specified.
 1. Door Construction: 2- to 2-1/4-inch overall thickness, with minimum 0.125-inch- thick, extruded-aluminum tubular rail and stile members. Mechanically fasten corners with reinforcing brackets that are deep penetration and fillet welded or that incorporate concealed tie rods.
 - a. Thermal Construction: High-performance plastic connectors separate aluminum members exposed to the exterior from members exposed to the interior.
 2. Door Design: Wide stile; 6-inch nominal width. Top rail shall have a minimum height of 8".
 - a. Accessible Doors: Smooth surfaced for width of door in area within 10 inches above floor or ground plane.
 3. Glazing Stops and Gaskets: Square, snap-on, extruded-aluminum stops and preformed gaskets.
 - a. Provide non-removable glazing stops on outside of door.

2.6 ACCESSORY MATERIALS

- A. Joint Sealants: For installation at perimeter of aluminum-framed systems, as specified in Division 7 Section "Joint Sealants."
- B. Bituminous Paint: Cold-applied asphalt-mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos, formulated for 30-mil thickness per coat.

- C. Conduit: Provide ½” diameter conduit attached to the framing system for the ElectroLynx cable pathway and Door Position Switch locations in the frames. Conduit and conduit connectors for electrical boxes shall be sealed against water penetration.
- D. Electrical Boxes: Provide electrical boxes for the attachment of the conduit for Harmony (H1) devices, electrified latch retraction devices, and door position switches. All of these electrical boxes shall be sealed against water penetration.

2.7 FABRICATION

- A. Form aluminum shapes before finishing.
- B. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.
- C. Framing Members, General: Fabricate components that, when assembled, have the following characteristics:
 - 1. Profiles that are sharp, straight, and free of defects or deformations.
 - 2. Accurately fitted joints with ends coped or mitered.
 - 3. Means to drain water passing joints, condensation occurring within framing members, and moisture migrating within the system to exterior.
 - 4. Physical and thermal isolation of glazing from framing members.
 - 5. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
 - 6. Provisions for field replacement of glazing from interior.
 - 7. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.
- D. Mechanically Glazed Framing Members: Fabricate for flush glazing (without projecting stops).
- E. Door Frames: Reinforce as required to support loads imposed by door operation, for installing hardware and the installation of the ElectroLynx and Door Position Switch cables.
 - 1. At exterior doors, provide compression weather stripping at fixed stops.
 - 2. At all frames requiring electrical please provide in conformance with the NEC. Prewire frame members before installation. All wiring shall be concealed.
- F. Doors: Reinforce doors as required for installing hardware.
 - 1. At pairs of exterior doors, provide sliding weather stripping retained in adjustable strip mortised into door edge.
 - 2. At exterior doors, provide weather sweeps applied to door bottoms.
 - 3. Where electrical hardware devices are used, prewire the door and provide raceways as required for the hardware application.

- G. Hardware Installation: Factory installed hardware to the greatest extent possible. Cut, drill, and tap for factory-installed hardware before applying finishes. All Sargent Harmony exit devices shall be installed by a Assa Abloy Certified Integrator.
- H. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

2.8 ALUMINUM FINISHES

- A. General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
- C. Exterior Storefront Systems: Color Anodic Finish, AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm or thicker.
 - 1. Color: Black.

2.9 DOOR HARDWARE

- A. General: Provide perimeter pile weather seals for all aluminum doors.
 - 1. Refer to section 087100 for the balance of the hardware requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. General:
 - 1. Comply with manufacturer's written instructions.
 - 2. Do not install damaged components.
 - 3. Fit joints to produce hairline joints free of burrs and distortion.
 - 4. Rigidly secure non-movement joints.
 - 5. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration.
 - 6. Seal joints watertight, unless otherwise indicated.

- B. Metal Protection:
1. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape or installing nonconductive spacers as recommended by manufacturer for this purpose.
 2. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.
- C. Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within the system to exterior.
- D. Set continuous sill members and flashing in full sealant bed as specified in Division 7 Section "Joint Sealants" and to produce weathertight installation.
- E. Install components plumb and true in alignment with established lines and grades, without warp or rack.
- F. Install glazing as specified in Division 8 Section "Glazing."
- G. Electrical: During installation, coordinate directly with the Electrical Contractor for the installation of the preinstalled frame cables into the wall. Frames receiving Harmony and Door position switch cables; conduit in frames shall extend 6" above finished frame height. Electrical Contractor shall connect to the conduit stub up and provide the required pathway from the stub up to the terminal location of the cables which will be at the power supplies.
- H. Entrances: Install to produce smooth operation and tight fit at contact points.
1. Exterior Entrances: Install to produce tight fit at weather stripping and weathertight closure.
 2. Field-Installed Hardware: Install surface-mounted hardware according to hardware manufacturers' written instructions using concealed fasteners to greatest extent possible.
- I. Install insulation materials as specified in Division 7 Section "Building Insulation."
- J. Install perimeter joint sealants as specified in Division 7 Section "Joint Sealants" and to produce weathertight installation.
- K. Erection Tolerances: Install aluminum-framed systems to comply with the following maximum tolerances:
1. Location and Plane: Limit variation from true location and plane to 1/8 inch in 12 feet; 1/4 inch over total length.
 2. Alignment:
 - a. Where surfaces abut in line, limit offset from true alignment to 1/16 inch.
 - b. Where surfaces meet at corners, limit offset from true alignment to 1/32 inch.
 3. Diagonal Measurements: Limit difference between diagonal measurement to 1/8 inch.

3.3 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Field Quality-Control Testing: Perform the following test on representative areas of aluminum-framed entrances and storefronts.
 - 1. Water-Spray Test: Before installation of interior finishes has begun, areas designated by Design Professional shall be tested according to AAMA 501.2 and shall not evidence water penetration.
 - a. Perform a minimum number of tests in areas as directed by Design Professional.
 - b. A minimum of 20 percent of all windows at each building shall be tested, as selected by the Design Professional.
- C. Aluminum-framed entrances and storefronts will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

3.4 ADJUSTING

- A. Entrances: Adjust operating hardware for smooth operation according to hardware manufacturers' written instructions.
 - 1. For doors accessible to people with disabilities, adjust closers to provide a 3-second closer sweep period for doors to move from a 70-degree open position to 3 inches from the latch measured to the leading door edge.

END OF SECTION 084113

SECTION 088000 - GLAZING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes glazing for the following products and applications, including those specified in other Sections where glazing requirements are specified by reference to this Section:
 - 1. Windows.
 - 2. Doors.
 - 3. Storefront framing.

1.3 DEFINITIONS

- A. Manufacturers of Glass Products: Firms that produce primary glass, as defined in referenced glazing publications.
- A. Glass Fabricators: Firms that produce fabricated glass products. Fabrication processes include cutting, heat processing, insulating, spandrel, laminating and other fabrication activities as defined in referenced glazing publications.
- B. Glass Thicknesses: Indicated by thickness designations in millimeters according to ASTM C 1036.
- C. Interspace: Space between lites of an insulating-glass unit that contains dehydrated air or a specified gas.
- D. Deterioration of Coated Glass: Defects developed from normal use that are attributed to the manufacturing process and not to causes other than glass breakage and practices for maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in metallic coating.
- E. Deterioration of Insulating Glass: Failure of hermetic seal under normal use that is attributed to the manufacturing process and not to causes other than glass breakage and practices for maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is the obstruction of vision by dust, moisture, or film on interior surfaces of glass.

1.4 REFERENCES

- A. American Architectural Manufacturers Association (AAMA):
 - 1. AAMA GDSG-1-1987: Glass Design for Sloped Glazing
 - 2. AAMA TIR-A7-1983 Sloped Glazing Guidelines
- B. American National Standards Institute (ANSI): ANSI Z 97.1 - Safety Glazing Materials Used in Buildings, Safety Performance Specifications and Methods of Test
- C. ASTM International (ASTM)
 - 1. ASTM C 1036 - Standard Specification for Flat Glass.
 - 2. ASTM C 1048 - Standard Specification for Heat-Treated Flat Glass--Kind HS, Kind FT Coated and Uncoated Glass
 - 3. ASTM C1172: Standard Specification for Laminated Architectural Flat Glass
 - 4. ASTM C 1376 - Standard Specification for Pyrolytic and Vacuum Deposition Coatings on Glass.
 - 5. ASTM E1886: Standard Test Method for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Missile(s) and Exposed to Cyclic Pressure Differentials
 - 6. ASTM E1996: Standard Specification for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Windborne Debris in Hurricanes
 - 7. ASTM E 2190 - Standard Specification for Insulating Glass Unit Performance and Evaluation.
- D. Consumer Product Safety Commission (CPSC): 16CFR-1201 - Safety Standard for Architectural Glazing Materials.
- E. Duplicate to above Underwriters Laboratory (UL)
 - 1. UL 263: Standard for Fire Tests of Building Construction and Material
 - 2. UL 9: Standard for Fire test of Window Assemblies
 - 3. UL 10B: Standard for Fire Tests of Door Assemblies
 - 4. UL 10C: Standard for Positive Pressure Fire Tests of Door Assemblies
- F. National Fire Protection Association (NFPA)
 - 1. NFPA 80: Standard for Fire Doors and Other Opening Protectives
 - 2. NFPA 257: Standard on Fire Test for Window and Glass Block Assemblies
 - 3. NFPA 252: Standard Methods of Fire Test of Door Assemblies

1.5 PERFORMANCE REQUIREMENTS

- A. General: Provide glazing systems capable of withstanding normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, and installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.
- B. Glass Design: Glass thickness designations indicated are minimums and are for detailing only. Confirm glass thicknesses by analyzing Project loads and in-service conditions. Provide glass lites in the thickness designations indicated for various size openings, but not less than thicknesses and in strengths (annealed or heat treated) required to meet or exceed the following criteria:

1. Glass Thicknesses: Select minimum glass thicknesses to comply with ASTM E 1300, according to the following requirements:
 - a. Specified Design Wind Loads: As indicated on drawings.
 - b. Probability of Breakage for Vertical Glazing: 8 lites per 1000 for lites set vertically or not more than 15 degrees off vertical and under wind action.
 - c. Maximum Lateral Deflection: For the following types of glass supported on all 4 edges, provide thickness required that limits center deflection at design wind pressure to 1/50 times the short side length or 1 inch, whichever is less.
 - 1) For monolithic-glass lites heat treated to resist wind loads.
 - 2) For insulating glass.
 - d. Minimum Glass Thickness for Exterior Lites: Not less than 6.0.
 - e. Thickness of Tinted and Heat-Absorbing Glass: Provide the same thickness for each tint color indicated throughout Project.

- C. Thermal Movements: Provide glazing that allows for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures acting on glass framing members and glazing components. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

- D. Thermal and Optical Performance Properties: Provide glass with performance properties specified based on manufacturer's published test data, as determined according to procedures indicated below:
 1. For monolithic-glass lites, properties are based on units with lites 6.0 mm thick.
 2. For insulating-glass units, properties are based on units with lites 6.0 mm thick and a nominal 1/2-inch-wide interspace.
 3. Center-of-Glass Values: Based on using LBNL WINDOW 7.4 computer program for the following methodologies:
 - a. U-Factors: NFRC 100 expressed as Btu/ sq. ft. x h x deg F.
 - b. Solar Heat Gain Coefficient: NFRC 200.
 - c. Solar Optical Properties: NFRC 300.

1.6 SUBMITTALS

- A. Product Data: For each glass product and glazing material indicated.
- B. Samples: For the following products, in the form of 12-inch- square Samples for glass.
 1. Each color of tinted float glass.
 2. Fire-resistive glazing products.
 3. Insulating glass for each designation indicated.

4. For each color (except black) of exposed glazing sealant indicated.
 5. Spandrel glass.
- C. Glazing Schedule: Use same designations indicated on Drawings for glazed openings in preparing a schedule listing glass types and thicknesses for each size opening and location.
- D. Product Certificates: Signed by manufacturers of glass and glazing products certifying that products furnished comply with requirements.
1. For solar-control low-e-coated glass, provide documentation demonstrating that manufacturer of coated glass is certified by coating manufacturer.
- E. Delegated-Design Submittal: For glass indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- F. Qualification Data: For installers.
- G. Product Test Reports: For each of the following types of glazing products:
1. Tinted float glass.
 2. Coated float glass.
 3. Insulating glass.
 4. Glazing sealants.
 5. Glazing gaskets.
- H. Warranties: Special warranties specified in this Section.
- I. Preconstruction Adhesion and Compatibility Testing: Test each glazing material type, tape sealant, gasket, glazing accessory, and glass-framing member for adhesion to and compatibility with elastomeric glazing sealants. Data based on previous testing of current sealant products, and glazing materials matching those specified is acceptable.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who has completed glazing similar in material, design, and extent to that indicated for this Project; whose work has resulted in glass installations with a record of successful in-service performance; and who employs glass installers for this Project who are certified under the National Glass Association Glazier Certification Program as Level 2 (Senior Glaziers) or Level 3 (Master Glaziers).
- B. Source Limitations for Glass: Obtain the following through one source from a single manufacturer for each glass type: clear float glass, tinted float glass, coated float glass, and insulating glass.
- C. Source Limitations for Glazing Accessories: Obtain glazing accessories through one source from a single manufacturer for each product and installation method indicated.
- D. Glazing for Fire-Rated Door Assemblies: Glazing for assemblies that comply with NFPA 80 and that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 252.

- E. Glazing for Fire-Rated Window Assemblies: Glazing for assemblies that comply with NFPA 80 and that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to NFPA 257.
- F. Safety Glazing Products: Comply with testing requirements in CPSC 16 CFR 1201 and, ANSI Z97.1.
- G. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below, unless more stringent requirements are indicated. Refer to these publications for glazing terms not otherwise defined in this Section or in referenced standards.
 - 1. GANA Publications: GANA's "Glazing Manual."
 - 2. GANA Publications: GANA's "Sealant Manual"
 - 3. IGMA Publication for Insulating Glass: SIGMA TM-3000, "Glazing Guidelines for Sealed Insulating Glass Units."
- H. Insulating-Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of the following testing and inspecting agency:
 - 1. Insulating Glass Certification Council.
 - 2. Associated Laboratories, Inc.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Protect glazing materials according to manufacturer's written instructions and as needed to prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.
- B. For insulating-glass units that will be exposed to substantial altitude changes, comply with insulating-glass manufacturer's written recommendations for venting and sealing to avoid hermetic seal ruptures.

1.9 PROJECT CONDITIONS

- A. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.
 - 1. Do not install liquid glazing sealants when ambient and substrate temperature conditions are outside limits permitted by glazing sealant manufacturer or below 40 deg F.

1.10 WARRANTY

- A. Manufacturer's Special Warranty for Coated-Glass Products: Manufacturer's standard form, made out to Owner and signed by coated-glass manufacturer agreeing to replace coated-glass units that deteriorate as defined in "Definitions" Article, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.
 - 1. Warranty Period: 10 years from date of Substantial Completion.
- B. Manufacturer's Special Warranty on Insulating Glass: Manufacturer's standard form, made out to Owner and signed by insulating-glass manufacturer agreeing to replace insulating-glass units that deteriorate as defined in "Definitions" Article, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.
 - 1. Warranty Period: 10 years from date of Substantial Completion.
- C. Manufacturer's Special Warranty for Laminated Glass: Manufacturer agrees to replace laminated-glass units that deteriorate within specified warranty period. Deterioration of laminated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.
 - 1. Warranty Period: Five (5) years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturers:
 - 1. AGC Glass North America (Basis of Design)
 - 2. Pilkington North America
 - 3. Vitro Architectural Glass
 - 4.
- B. Acceptable Fabricators
 - 1. American Insulated Glass
 - 2. OldCastle Building Envelope
 - 3. Trulite Glass and Aluminum Solutions
 - 4. Viracon

2.2 GLASS PRODUCTS

- A. Annealed Float Glass: ASTM C 1036, Type I (transparent flat glass), Quality-Q3; of class indicated.
 - 1. Clear Float Glass: Class I (clear); with a minimum 88 percent visible light transmission and a minimum solar heat gain coefficient of 0.84.

2. Tinted Float Glass: Type 1, Class II (tinted) , Bronze, with a minimum 54 percent visible light transmission and a minimum solar heat gain coefficient of .63.
- B. Heat-Treated Float Glass: ASTM C 1048; Type I (transparent flat glass); Quality-Q3; of class, kind, and condition indicated.
1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed, unless otherwise indicated.
 2. Provide Kind HS (heat-strengthened) float glass in place of annealed float glass where needed to resist thermal stresses induced by differential shading of individual glass lites and to comply with glass design requirements specified in Part 1 "Performance Requirements" Article.
 3. For uncoated glass, comply with requirements for Condition A.
 4. Provide Kind FT (fully tempered) float glass in place of annealed or Kind HS (heat-strengthened) float glass where indicated.
- C. Insulating-Glass Units, General: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace and complying with ASTM E 2190 units and with requirements specified in this Article and in Part 2 "Insulating-Glass Units" Article.
1. Provide Kind FT (fully tempered) glass lites.
 2. Overall Unit Thickness and Thickness of Each Lite: Dimensions indicated for insulating-glass units are nominal and the overall thicknesses of units are measured perpendicularly from outer surfaces of glass lites at unit's edge.
 3. Sealing System: Dual seal, with primary and secondary sealants as follows:
 - a. Primary Seal: Polyisobutylene
 - b. Secondary Seal: Two-part Silicone
 - a. Spacer Specifications: Bent, welded, or fused aluminum box spacer of color indicated. Mill Finish or Clear Anodized
 5. Desiccant: Molecular Sieve or silica gel, or blend of both.

2.3 FIRE-PROTECTION-RATED GLAZING

- A. Fire-Protection-Rated Glazing, General: Listed and labeled by a testing agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 252 for door assemblies and NFPA 257 for window assemblies.
- B. Laminated Ceramic Glazing: Laminated glass made from 2 plies of clear, ceramic flat glass; 5/16-inch total nominal thickness; complying with testing requirements in 16 CFR 1201 for Category II materials, and passes the hose stream test.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Nippon Electric Glass Co., Ltd. (distributed by Technical Glass Products); FireLite Plus.
 - b. Schott North America, Inc.; Laminated Pyran Crystal.
 - c. Vetrotech Saint-Gobain; SGG Keralite FR-L.

2.4 GLAZING GASKETS

- A. Dense Compression Gaskets: Molded or extruded gaskets of material indicated below, complying with standards referenced with name of elastomer indicated below, and of profile and hardness required to maintain watertight seal:
1. Neoprene, ASTM C 864.
 2. EPDM, ASTM C 864.
 3. Silicone, ASTM C 1115.
 4. Thermoplastic polyolefin rubber, ASTM C 1115.
 5. Any material indicated above.
- B. Soft Compression Gaskets: Extruded or molded, closed-cell, integral-skinned gaskets of material indicated below; complying with ASTM C 509, Type II, black; and of profile and hardness required to maintain watertight seal:
1. Neoprene.
 2. EPDM.
 3. Silicone.
 4. Thermoplastic polyolefin rubber.
 5. Any material indicated above.
- C. Lock-Strip Gaskets: Neoprene extrusions in size and shape indicated, fabricated into frames with molded corner units and zipper lock-strips, complying with ASTM C 542, black.

2.5 GLAZING SEALANTS

- A. General: Provide products of type indicated, complying with the following requirements:
1. Compatibility: Select glazing sealants that are compatible with one another and with other materials they will contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
 2. Suitability: Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.
 3. Colors of Exposed Glazing Sealants: As selected by Design Professional from manufacturer's full range.
- B. Elastomeric Glazing Sealants: Comply with ASTM C 920 and other requirements indicated for each liquid-applied chemically curing sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.
1. Neutral-Curing Silicone Glazing Sealants:
 - a. Products:
 - 1) Dow Corning Corporation; 791.
 - 2) Dow Corning Corporation; 795.

- 3) GE Silicones; SilPruf NB SCS9000.
- 4) GE Silicones; UltraPruf II SCS2900.
- 5) Pecora Corporation; 865.
- 6) Pecora Corporation; 895.
- 7) Pecora Corporation; 898.

- b. Type and Grade: S (single component) and NS (nonsag).
- c. Class: 50.
- d. Use Related to Exposure: NT (nontraffic).
- e. Uses Related to Glazing Substrates: M, G, A, and, as applicable to glazing substrates indicated, O.

- 1) Use O Glazing Substrates: Coated glass, color anodic aluminum, aluminum coated with a high-performance coating, galvanized steel, and wood.

- C. Glazing Sealants for Fire-Resistive Glazing Products: Identical to products used in test assemblies to obtain fire-protection rating.

2.6 GLAZING TAPES

- A. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based elastomeric tape with a solids content of 100 percent; non-staining and non-migrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; packaged on rolls with a release paper backing; and complying with ASTM C 1281 and AAMA 800 for products indicated below:

1. AAMA 804.3 tape.
2. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
3. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.

- B. Expanded Cellular Glazing Tapes: Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; packaged on rolls with release liner protecting adhesive; and complying with AAMA 800 for the following types:

1. Type 1, for glazing applications in which tape acts as the primary sealant.
2. Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.

2.7 MISCELLANEOUS GLAZING MATERIALS

- A. General: Provide products of material, size, and shape complying with referenced glazing standard, requirements of manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.

- B. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.

- C. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.
- D. Spacers: Elastomeric blocks or continuous extrusions with a Shore, Type A durometer hardness required by glass manufacturer to maintain glass lites in place for installation indicated.
- E. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side walking).
- F. Cylindrical Glazing Sealant Backing: ASTM C 1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.
- G. Perimeter Insulation for Fire-Resistive Glazing: Identical to product used in test assembly to obtain fire-resistance rating.

2.8 FABRICATION OF GLAZING UNITS

- A. Fabricate glazing units in sizes required to glaze openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.
- B. Clean-cut or flat-grind vertical edges of butt-glazed monolithic lites in a manner that produces square edges with slight kerfs at junctions with outdoor and indoor faces.

2.9 MONOLITHIC FLOAT-GLASS UNITS

- A. Uncoated Clear Float-Glass Units: Class 1 (clear) Kind FT (fully tempered) float glass.
 - 1. Thickness: Minimum 6.0 mm.
- B. Uncoated Tinted Float-Glass Units: Class 2 (tinted) Kind FT (fully tempered) float glass.
 - 1. Thickness: Minimum 6.0 mm.
 - 2. Tint Color: Match Design Professional sample.

2.10 FIRE-PROTECTION-RATED GLAZING TYPES

- A. Glass Type: 20-minute, 45-minute, 60-minute, 90-minute, and 120-minute fire-rated glazing with hose stream test; laminated ceramic glazing.
 - 1. Provide safety glazing labeling.

2.11 INSULATING-GLASS UNITS

- A. LOW-E, Tinted Laminated Insulating-Glass Units:

1. Basis of Design: AGC Glass Energy Select 25 Gray
2. Overall Unit Thickness: Minimum 1-5/16 inch nominal.
3. Interspace Content: Air.
4. Outdoor Lite: Class 2 (tinted) float glass, coated.
 - a. Tint Color: Gray
 - b. Thickness: 6mm
 - c. Kind FT (fully tempered).
 - d. Low-E Coating: Surface 2
5. Indoor Lite: Clear laminated float glass.
 - a. Nominal Thickness: 6mm minimum.
 - b. Kind HS heat strengthened
 - c. Interlayer: .090" Clear polyvinyl butyral (PVB)
6. Performance:
 - a. Visible Light Transmittance: 39% minimum
 - b. Exterior Reflectance: 7% maximum
 - c. SHGC: .26 maximum
 - d. Winter U-Value: .28 maximum
 - e. Summer U-Value: .26 maximum

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine framing glazing, with Installer present, for compliance with the following:
 1. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.
 2. Presence and functioning of weep system.
 3. Minimum required face or edge clearances.
 4. Effective sealing between joints of glass-framing members.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.

3.3 GLAZING, GENERAL

- A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.

- B. Glazing channel dimensions, as indicated on Drawings, provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances. Adjust as required by Project conditions during installation.
- C. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass is glass with edge damage or other imperfections that, when installed, could weaken glass and impair performance and appearance.
- D. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction sealant-substrate testing.
- E. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.
- F. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.
- G. Provide spacers for glass lites where length plus width is larger than 50 inches as follows:
 1. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.
 2. Provide 1/8-inch minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.
- H. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.
- I. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.
- J. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.
- K. Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended by gasket manufacturer.

3.5 GASKET GLAZING (DRY)

- A. Fabricate compression gaskets in lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.
- B. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.

- C. Center glass lites in openings on setting blocks and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.
- D. Install gaskets so they protrude past face of glazing stops.

3.7 LOCK-STRIP GASKET GLAZING

- A. Comply with ASTM C 716 and gasket manufacturer's written instructions. Provide supplementary wet seal and weep system, unless otherwise indicated.

3.8 CLEANING AND PROTECTION

- A. Protect exterior glass from damage immediately after installation by attaching crossed streamers to framing held away from glass. Do not apply markers to glass surface. Remove nonpermanent labels, and clean surfaces.
- B. Protect glass from contact with contaminating substances resulting from construction operations, including weld splatter. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended by glass manufacturer.
- C. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains; remove as recommended in writing by glass manufacturer.
- D. Remove and replace glass that is broken, chipped, cracked, or abraded or that is damaged from natural causes, accidents, and vandalism, during construction period.
- E. Wash glass on both exposed surfaces in each area of Project not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended in writing by glass manufacturer.

END OF SECTION 088000

SECTION 089000 - LOUVERS AND VENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Fixed, extruded-aluminum louvers.
- B. Related Sections include the following:
 - 1. Division 7 Section "Joint Sealants" for sealants installed in perimeter joints between louver frames and adjoining construction.
 - 2. Division 8 Section "Steel Doors and Frames" for louvers in hollow-metal doors and frames.
 - 3. Division 23 Sections for louvers that are a part of mechanical equipment.

1.3 DEFINITIONS

- A. Louver Terminology: Definitions of terms for metal louvers contained in AMCA 501 apply to this Section unless otherwise defined in this Section or in referenced standards.
- B. Drainable-Blade Louver: Louver with blades having gutters that collect water and drain it to channels in jambs and mullions, which carry it to bottom of unit and away from opening.

1.4 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Provide louvers capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without permanent deformation of louver components, noise or metal fatigue caused by louver blade rattle or flutter, or permanent damage to fasteners and anchors. Wind pressures shall be considered to act on vertical projection of louvers.
 - 1. Wind Loads: Determine loads based on pressures as indicated on Drawings.
- B. Seismic Performance: Provide louvers capable of withstanding the effects of earthquake motions determined according to ASCE 7, "Minimum Design Loads for Buildings and Other Structures": Section 9, "Earthquake Loads."

- C. Thermal Movements: Provide louvers that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 - 1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.
- D. Air-Performance, Water-Penetration, Air-Leakage, and Wind-Driven Rain Ratings: Provide louvers complying with performance requirements indicated, as demonstrated by testing manufacturer's stock units identical to those provided, except for length and width according to AMCA 500-L.

1.5 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For louvers and accessories. Include plans, elevations, sections, details, and attachments to other Work. Show blade profiles, angles, and spacing.
 - 1. For installed louvers and vents indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- C. Samples for Initial Selection: For units with factory-applied color finishes.
- D. Samples for Verification: For each type of metal finish required.

1.6 QUALITY ASSURANCE

- A. Source Limitations: Obtain louvers and vents through one source from a single manufacturer where indicated to be of same type, design, or factory-applied color finish.
- B. Welding: Qualify procedures and personnel according to the following:
 - 1. AWS D1.2, "Structural Welding Code--Aluminum."
 - 2. AWS D1.3, "Structural Welding Code--Sheet Steel."
- C. SMACNA Standard: Comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" for fabrication, construction details, and installation procedures.
- D. UL and NEMA Compliance: Provide motors and related components for motor-operated adjustable louvers that are listed and labeled by UL and comply with applicable NEMA standards.

1.7 PROJECT CONDITIONS

- A. Field Measurements: Verify louver openings by field measurements before fabrication and indicate measurements on Shop Drawings.

1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish opening dimensions and proceed with fabricating louvers without field measurements. Coordinate construction to ensure that actual opening dimensions correspond to established dimensions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Louvers:
 - a. Airline Products Co.
 - b. Airolite Company (The).
 - c. American Warming and Ventilating, Inc.
 - d. Arrow United Industries.
 - e. Carnes Company, Inc.
 - f. Cesco Products.
 - g. Construction Specialties, Inc.
 - h. Dowco Products Group; Safe-Air of Illinois, Inc.
 - i. Greenheck.
 - j. Industrial Louvers, Inc.
 - k. Louvers & Dampers, Inc.
 - l. Metal Form Manufacturing Company, Inc.
 - m. NCA Manufacturing, Inc.
 - n. Nystrom Building Products.
 - o. Reliable Products; Hart & Cooley, Inc.
 - p. Ruskin Company; Tomkins PLC.
 - q. Vent Products Company, Inc.

- B. In other Part 2 articles where titles below introduce lists, the following requirements apply for product selection:

1. Products: Subject to compliance with requirements, provide one of the products specified.

2.2 MATERIALS

- A. Aluminum Extrusions: ASTM B 221, alloy 6063-T5 or T-52.
- B. Aluminum Sheet: ASTM B 209, alloy 3003 or 5005 with temper as required for forming, or as otherwise recommended by metal producer for required finish.
- C. Aluminum Castings: ASTM B 26/B 26M, alloy 319.
- D. Galvanized Steel Sheet: ASTM A 653/A 653M, G90 zinc coating, mill phosphatized.

- E. Fasteners: Of same basic metal and alloy as fastened metal or 300 Series stainless steel, unless otherwise indicated. Do not use metals that are incompatible with joined materials.
 - 1. Use types and sizes to suit unit installation conditions.
 - 2. Use hex-head or Phillips pan-head screws for exposed fasteners, unless otherwise indicated.
- F. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.3 FABRICATION, GENERAL

- A. Assemble louvers in factory to minimize field splicing and assembly. Disassemble units as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.
- B. Vertical Assemblies: Where height of louver units exceeds fabrication and handling limitations, fabricate units to permit field-bolted assembly with close-fitting joints in jambs and mullions, reinforced with splice plates.
 - 1. Continuous Vertical Assemblies: Fabricate units without interrupting blade-spacing pattern.
- C. Maintain equal louver blade spacing to produce uniform appearance.
- D. Fabricate frames, including integral sills, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.
 - 1. Frame Type: Channel, unless otherwise indicated.
- E. Include supports, anchorages, and accessories required for complete assembly.
- F. Where indicated, provide subsills made of same material as louvers or extended sills for recessed louvers.
- G. Join frame members to each other and to fixed louver blades with fillet welds concealed from view, unless otherwise indicated or size of louver assembly makes bolted connections between frame members necessary.
- H. Join frame members to each other and to fixed louver blades with fillet welds, threaded fasteners, or both, as standard with louver manufacturer, concealed from view, unless otherwise indicated or size of louver assembly makes bolted connections between frame members necessary.

2.4 FIXED, EXTRUDED-ALUMINUM LOUVERS

- A. Horizontal, Drainable-Blade Louver:
 - 1. Louver Depth: Coordinate with wall thickness, minimum 6".

2. Frame and Blade Nominal Thickness: As required to comply with structural performance requirements, but not less than 0.080 inch for blades and 0.080 inch for frames.
3. Mullion Type: Exposed.
4. AMCA Seal: Mark units with AMCA Certified Ratings Seal.

2.5 LOUVER SCREENS

- A. General: Provide screen at each exterior louver.
 1. Screen Location for Fixed Louvers: Interior face.
 2. Screening Type: Insect screening.
- B. Secure screens to louver frames with stainless-steel machine screws, spaced a maximum of 6 inches from each corner and at 12 inches o.c.
- C. Louver Screen Frames: Fabricate with mitered corners to louver sizes indicated.
 1. Metal: Same kind and form of metal as indicated for louver to which screens are attached. Reinforce extruded-aluminum screen frames at corners with clips.
 2. Finish: Same finish as louver frames to which louver screens are attached.
 3. Type: Non-rewirable, U-shaped frames for permanently securing screen mesh.
- D. Louver Screening for Aluminum Louvers:
 1. Insect Screening: Aluminum, 18-by-16 mesh, 0.012-inch wire.

2.6 FINISHES, GENERAL

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Finish louvers after assembly.

2.7 ALUMINUM FINISHES

- A. High-Performance Organic-Coating Finish: AA-C12C42R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: acid-chromate-fluoride-phosphate conversion coating; Organic Coating: as specified below). Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 1. Fluoropolymer Two-Coat Coating System: Manufacturer's standard two-coat, thermocured system consisting of specially formulated inhibitive primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight; complying with AAMA 2605.
 - a. Color and Gloss: Medium Bronze, Match Design Professional's sample.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and openings, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Coordinate setting drawings, diagrams, templates, instructions, and directions for installation of anchorages that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to Project site.

3.3 INSTALLATION

- A. Locate and place louvers and vents level, plumb, and at indicated alignment with adjacent work.
- B. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.
- C. Form closely fitted joints with exposed connections accurately located and secured.
- D. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.
- E. Repair finishes damaged by cutting, welding, soldering, and grinding. Restore finishes so no evidence remains of corrective work. Return items that cannot be refinished in the field to the factory, make required alterations, and refinish entire unit or provide new units.
- F. Protect galvanized and nonferrous-metal surfaces from corrosion or galvanic action by applying a heavy coating of bituminous paint on surfaces that will be in contact with concrete, masonry, or dissimilar metals.
- G. Install concealed gaskets, flashings, joint fillers, and insulation as louver installation progresses, where weathertight louver joints are required. Comply with Division 7 Section "Joint Sealants" for sealants applied during louver installation.

3.4 ADJUSTING AND CLEANING

- A. Test operation of adjustable louvers and adjust as needed to produce fully functioning units that comply with requirements.
- B. Clean exposed surfaces of louvers and vents that are not protected by temporary covering, to remove fingerprints and soil during construction period. Do not let soil accumulate until final cleaning.

- C. Before final inspection, clean exposed surfaces with water and a mild soap or detergent not harmful to finishes. Thoroughly rinse surfaces and dry.
- D. Restore louvers and vents damaged during installation and construction so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by Design Professional, remove damaged units and replace with new units.
 - 1. Touch up minor abrasions in finishes with air-dried coating that matches color and gloss of, and is compatible with, factory-applied finish coating.

END OF SECTION 089000

SECTION 092900 - GYPSUM BOARD ASSEMBLIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Interior gypsum wallboard.
 - 2. Non-load-bearing steel framing.
- B. Related Sections include the following:
 - 1. Division 5 Section "Cold-Formed Metal Framing for load-bearing steel framing.
 - 2. Division 7 Section "Building Insulation for insulation and vapor retarders installed in gypsum board assemblies.
 - 3. Division 9 Sections, "Interior Painting" and "Exterior Painting".

1.3 DEFINITIONS

- A. Gypsum Board Terminology: Refer to ASTM C 11 for definitions of terms for gypsum board assemblies not defined in this Section or in other referenced standards.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Show locations, fabrication, and installation of control and expansion joints, including plans, elevations, sections, details of components, and attachments to other units of Work.
- C. Samples: For the following products:
 - 1. Trim Accessories: Full-size sample in 12-inch- long length for each trim accessory indicated.

1.5 QUALITY ASSURANCE

- A. Fire-Test-Response Characteristics: For gypsum board assemblies with fire-resistance ratings, provide materials and construction identical to those tested in assembly indicated according to

ASTM E 119 by an independent testing and inspecting agency acceptable to authorities having jurisdiction.

1. Fire-Resistance-Rated Assemblies: Indicated by design designations from FM's "Approval Guide, Building Products." UL's "Fire Resistance Directory."
- B. Sound Transmission Characteristics: For gypsum board assemblies with STC ratings, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by a qualified independent testing agency.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in original packages, containers, or bundles bearing brand name and identification of manufacturer or supplier.
- B. Store materials inside under cover and keep them dry and protected against damage from weather, direct sunlight, surface contamination, corrosion, construction traffic, and other causes. Stack gypsum panels flat to prevent sagging.

1.7 PROJECT CONDITIONS

- A. Environmental Limitations: Comply with ASTM C 840 requirements or gypsum board manufacturer's written recommendations, whichever are more stringent.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Steel Framing and Furring:
 - a. Clark Steel Framing Systems.
 - b. Consolidated Systems, Inc.
 - c. Dale Industries, Inc. - Dale/Incor.
 - d. Dietrich Industries, Inc.
 - e. MarinoWare; Division of Ware Ind.
 - f. National Gypsum Company.
 - g. Scafco Corporation.
 - h. Unimast, Inc.
 - i. Western Metal Lath & Steel Framing Systems.
 2. Gypsum Board and Related Products:
 - a. American Gypsum Co.
 - b. G-P Gypsum Corp.

- c. National Gypsum Company.
- d. United States Gypsum Co.

2.2 STEEL SUSPENDED CEILING AND SOFFIT FRAMING

- A. Components, General: Comply with ASTM C 754 for conditions indicated.
- B. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.0625-inch- diameter wire, or double strand of 0.0475-inch- diameter wire.
- C. Hangers: As follows:
 - 1. Wire Hangers: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.162-inch diameter.
 - 2. Rod Hangers: ASTM A 510, mild carbon steel.
 - a. Diameter: 1/4-inch.
 - b. Protective Coating: ASTM A 153/A 153M, hot-dip galvanized.
 - 3. Flat Hangers: Commercial-steel sheet, ASTM A 653/A 653M, G40, hot-dip galvanized.
 - 4. Angle Hangers: ASTM A 653/A 653M, hot-dip galvanized commercial-steel sheet.
 - a. Minimum Base Metal Thickness: 0.0312 inch.
 - b. Size: 2 by 2 inches.
- D. Carrying Channels: Cold-rolled, commercial-steel sheet with a base metal thickness of 0.0538 inch, a minimum 1/2-inch- wide flange, with ASTM A 653/A 653M, G40, hot-dip galvanized zinc coating.
 - 1. Depth: As indicated 2-1/2 inches.
- E. Furring Channels (Furring Members): Commercial-steel sheet with ASTM A 653/A 653M, G40, hot-dip galvanized zinc coating.
 - 1. Cold Rolled Channels: 0.0538-inch bare steel thickness, with minimum 1/2-inch- wide flange, 3/4 inch deep.
 - 2. Steel Studs: ASTM C 645.
 - a. Minimum Base Metal Thickness: 0.0312 inch.
 - b. Depth: 2-1/2 inches.
 - 3. Hat-Shaped, Rigid Furring Channels: ASTM C 645, 7/8 inch deep.
 - a. Minimum Base Metal Thickness: 0.0312 inch.

2.3 STEEL PARTITION AND SOFFIT FRAMING

- A. Components, General: As follows:

1. Comply with ASTM C 754 for conditions indicated.
 2. Steel Sheet Components: Complying with ASTM C 645 requirements for metal and with ASTM A 653/A 653M, G40, hot-dip galvanized, zinc coating.
- B. Steel Studs and Runners: ASTM C 645.
1. Minimum Base Metal Thickness: 0.0312 inch.
 2. Depth: As indicated.
- C. Proprietary Deflection Track: Steel sheet top runner manufactured to prevent cracking of gypsum board applied to interior partitions resulting from deflection of structure above; in thickness indicated for studs and in width to accommodate depth of studs.
1. Product: Subject to compliance with requirements, provide one of the following:
 - a. Delta Star, Inc., Superior Metal Trim; Superior Flex Track System (SFT).
 - b. Metal-Lite, Inc.; Slotted Track.
 - c. Clark-Dietrich.
- D. Proprietary Firestop Track: Top runner manufactured to allow partition heads to expand and contract with movement of the structure while maintaining continuity of fire-resistance-rated assembly indicated; in thickness not less than indicated for studs and in width to accommodate depth of studs.
1. Product: Subject to compliance with requirements, provide one of the following:
 - a. Fire Trak Corp.; Fire Trak attached to studs with Fire Trak Slip Clip.
 - b. Metal-Lite, Inc.; The System.
 - c. Clark-Dietrich.
- E. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.
1. Minimum Base Metal Thickness: 0.0312 inch.
- F. Cold-Rolled Channel Bridging: 0.0538-inch bare steel thickness, with minimum 1/2-inch- wide flange.
1. Depth: 1-1/2 inches.
 2. Clip Angle: 1-1/2 by 1-1/2 inch, 0.068-inch- thick galvanized steel.
- G. Hat-Shaped, Rigid Furring Channels: ASTM C 645.
1. Minimum Base Metal Thickness: 0.0312 inch.
 2. Depth: 7/8 inch.
- H. Cold-Rolled Furring Channels: 0.0538-inch bare steel thickness, with minimum 1/2-inch- wide flange.
1. Depth: 3/4 inch.

2. Furring Brackets: Adjustable, corrugated-edge type of steel sheet with minimum bare steel thickness of 0.0312 inch.
 3. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.0625-inch-diameter wire, or double strand of 0.0475-inch-diameter wire.
- I. Z-Shaped Furring: With slotted or nonslotted web, face flange of 1-1/4 inches, wall attachment flange of 7/8 inch, minimum bare metal thickness of 0.0179 inch, and depth required to fit insulation thickness indicated.
 - J. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.

2.4 INTERIOR GYPSUM BOARD

- A. General: Complying with ASTM C 36/C 36M or ASTM C 1396/C 1396M, as applicable to type of gypsum board indicated and whichever is more stringent.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Gypsum Co.
 - b. BPB America Inc.
 - c. G-P Gypsum.
 - d. Lafarge North America Inc.
 - e. National Gypsum Company.
 - f. PABCO Gypsum.
 - g. Temple.
 - h. USG Corporation.
- B. Type X:
 1. Thickness: 5/8 inch.
 2. Long Edges: Tapered.
 3. Location: All locations unless noted otherwise.
- C. Water-Resistant Gypsum Board: ASTM C630/C 630M.
 1. Core: 5/8 inch, Type X.
 2. Location: Toilets, showers, janitor closets, non-conditioned spaces, mechanical and electrical rooms.

2.5 TRIM ACCESSORIES

- A. Interior Trim: ASTM C 1047.
 1. Material: Galvanized or aluminum-coated steel sheet or rolled zinc.
 2. Shapes:
 - a. Cornerbead: Use at outside corners.

- b. LC-Bead: J-shaped; exposed long flange receives joint compound.
- c. L-Bead: L-shaped; exposed long leg receives joint compound.
- d. Expansion (Control) Joint: Use where indicated Insert requirements.

B. Aluminum Trim: Extruded accessories of profiles and dimensions indicated.

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Fry Reglet Corp.
 - b. Gordon, Inc.
 - c. MM Systems Corporation.
 - d. Pittcon Industries.
- 2. Aluminum: Alloy and temper with not less than the strength and durability properties of ASTM B 221, alloy 6063-T5.
- 3. Finish: Corrosion-resistant primer compatible with joint compound and finish materials specified.

2.6 JOINT TREATMENT MATERIALS

A. General: Comply with ASTM C 475.

B. Joint Tape:

- 1. Interior Gypsum Wallboard: Paper

C. Joint Compound for Interior Gypsum Wallboard: For each coat use formulation that is compatible with other compounds applied on previous or for successive coats.

- 1. Prefilling: At open joints, rounded or beveled panel edges, and damaged surface areas, use setting-type taping compound.
- 2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use setting-type taping compound.

2.7 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written recommendations.

B. Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.

- 1. Use adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Steel Drill Screws: ASTM C 1002, unless otherwise indicated.

1. Use screws complying with ASTM C 954 for fastening panels to steel members from 0.033 to 0.112 inch thick.
 2. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.
- D. Isolation Strip at Exterior Walls:
1. Asphalt-Saturated Organic Felt: ASTM D 226, Type I (No. 15 asphalt felt), nonperforated.
 2. Foam Gasket: Adhesive-backed, closed-cell vinyl foam strips that allow fastener penetration without foam displacement, 1/8 inch thick, in width to suit steel stud size.
- E. Sound Attenuation Blankets: ASTM C 665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.
1. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.
- F. Thermal Insulation: As specified in Division 7 Section "Building Insulation."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Suspended Ceilings: Coordinate installation of ceiling suspension systems with installation of overhead structure to ensure that inserts and other provisions for anchorages to building structure have been installed to receive ceiling hangers at spacing required to support ceilings and that hangers will develop their full strength.
1. Furnish concrete inserts and other devices indicated to other trades for installation in advance of time needed for coordination and construction.

3.3 INSTALLING STEEL FRAMING, GENERAL

- A. Installation Standards: ASTM C 754, and ASTM C 840 requirements that apply to framing installation.
- B. Install supplementary framing, blocking, and bracing at terminations in gypsum board assemblies to support fixtures, equipment services, heavy trim, grab bars, toilet accessories,

furnishings, or similar construction. Comply with details indicated and with gypsum board manufacturer's written recommendations or, if none available, with United States Gypsum's "Gypsum Construction Handbook."

- C. Isolate steel framing from building structure at locations indicated to prevent transfer of loading imposed by structural movement.
 - 1. Isolate ceiling assemblies where they abut or are penetrated by building structure.
 - 2. Isolate partition framing and wall furring where it abuts structure, except at floor. Install slip-type joints at head of assemblies that avoid axial loading of assembly and laterally support assembly.
 - a. Use proprietary deflection track.
 - b. Use proprietary firestop track.
- D. Do not bridge building control and expansion joints with steel framing or furring members. Frame both sides of joints independently.

3.4 INSTALLING STEEL SUSPENDED CEILING AND SOFFIT FRAMING

- A. Suspend ceiling hangers from building structure as follows:
 - 1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or ceiling suspension system. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
 - 2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with the location of hangers required to support standard suspension system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards.
 - 3. Secure wire hangers by looping and wire-tying, either directly to structures or to inserts, eyescrews, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause them to deteriorate or otherwise fail.
 - 4. Secure hangers to structure, including intermediate framing members, by attaching to inserts, eyescrews, or other devices and fasteners that are secure and appropriate for structure and hanger, and in a manner that will not cause hangers to deteriorate or otherwise fail.
 - 5. Do not support ceilings directly from permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.
 - 6. Do not attach hangers to steel deck tabs.
 - 7. Do not attach hangers to steel roof deck. Attach hangers to structural members.
 - 8. Do not connect or suspend steel framing from ducts, pipes, or conduit.
- B. Installation Tolerances: Install steel framing components for suspended ceilings so members for panel attachment are level to within 1/8 inch in 12 feet measured lengthwise on each member and transversely between parallel members.

- C. Sway-brace suspended steel framing with hangers used for support.
- D. For exterior soffits, install cross bracing and framing to resist wind uplift.
- E. Wire-tie or clip furring channels to supports.
- F. Install suspended steel framing components in sizes and spacings indicated, but not less than that required by the referenced steel framing and installation standards.
 - 1. Hangers: 24 inches o.c.
 - 2. Carrying Channels (Main Runners): 24 inches o.c.
 - 3. Furring Channels (Furring Members): 24 inches o.c.

3.5 INSTALLING STEEL PARTITION AND SOFFIT FRAMING

- A. Install tracks (runners) at floors, ceilings, and structural walls and columns where gypsum board assemblies abut other construction.
 - 1. Where studs are installed directly against exterior walls, install asphalt-felt isolation strip between studs and wall.
- B. Installation Tolerance: Install each steel framing and furring member so fastening surfaces vary not more than 1/8 inch from the plane formed by the faces of adjacent framing.
- C. Extend partition framing full height to structural supports or substrates above suspended ceilings, except where partitions are indicated to terminate at suspended ceilings. Continue framing over frames for doors and openings and frame around ducts penetrating partitions above ceiling to provide support for gypsum board.
 - 1. Cut studs 1/2 inch short of full height to provide perimeter relief.
 - 2. For fire-resistance-rated and STC-rated partitions that extend to the underside of floor/roof slabs and decks or other continuous solid-structure surfaces to obtain ratings, install framing around structural and other members extending below floor/roof slabs and decks, as needed to support gypsum board closures and to make partitions continuous from floor to underside of solid structure.
 - a. Terminate partition framing at suspended ceilings where indicated.
- D. Install steel studs and furring at the following spacings:
 - 1. Single-Layer Construction: 16 inches o.c.
- E. Install steel studs so flanges point in the same direction and leading edge or end of each panel can be attached to open (unsupported) edges of stud flanges first.
- F. Frame door openings to comply with GA-600 and with gypsum board manufacturer's applicable written recommendations, unless otherwise indicated. Screw vertical studs at jambs to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.

1. Install two studs at each jamb, unless otherwise indicated.
 2. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch clearance from jamb stud to allow for installation of control joint.
 3. Extend jamb studs through suspended ceilings and attach to underside of floor or roof structure above.
- G. Frame openings other than door openings the same as required for door openings, unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.
- H. Z-Furring Members:
1. Erect insulation vertically and hold in place with Z-furring members spaced 24 inches o.c.
 2. Except at exterior corners, securely attach narrow flanges of furring members to wall with concrete stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches o.c.
 3. At exterior corners, attach wide flange of furring members to wall with short flange extending beyond corner; on adjacent wall surface, screw-attach short flange of furring channel to web of attached channel. At interior corners, space second member no more than 12 inches from corner and cut insulation to fit.
 4. Until gypsum board is installed, hold insulation in place with 10-inch staples fabricated from 0.0625-inch- diameter, tie wire and inserted through slot in web of member.

3.6 APPLYING AND FINISHING PANELS, GENERAL

- A. Gypsum Board Application and Finishing Standards: ASTM C 840 and GA-216.
- B. Install sound attenuation blankets before installing gypsum panels, unless blankets are readily installed after panels have been installed on one side.
- C. Install ceiling board panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in the central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.
- D. Install gypsum panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch of open space between panels. Do not force into place.
- E. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.
- F. Attach gypsum panels to steel studs so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.
- G. Attach gypsum panels to framing provided at openings and cutouts.

- H. Do not attach gypsum panels across the flat grain of wide-dimension lumber, including floor joists and headers. Float gypsum panels over these members using resilient channels, or provide control joints to counteract wood shrinkage.
- I. Form control and expansion joints with space between edges of adjoining gypsum panels.
- J. Cover both faces of steel stud partition framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.
 - 1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. in area.
 - 2. Fit gypsum panels around ducts, pipes, and conduits.
 - 3. Where partitions intersect open concrete coffers, concrete joists, and other structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by coffers, joists, and other structural members; allow 1/4- to 3/8-inch-wide joints to install sealant.
- K. Isolate perimeter of non-load-bearing gypsum board partitions at structural abutments, except floors. Provide 1/4- to 1/2-inch- wide spaces at these locations, and trim edges with U-bead edge trim where edges of gypsum panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.
- L. Floating Construction: Where feasible, including where recommended in writing by manufacturer, install gypsum panels over wood framing, with floating internal corner construction.
- M. STC-Rated Assemblies: Seal construction at perimeters, behind control and expansion joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C 919 and manufacturer's written recommendations for locating edge trim and closing off sound-flanking paths around or through gypsum board assemblies, including sealing partitions above acoustical ceilings.
- N. Space fasteners in gypsum panels according to referenced gypsum board application and finishing standard and manufacturer's written recommendations.
 - 1. Space screws a maximum of 12 inches o.c. for vertical applications.
- O. Space fasteners in panels that are tile substrates a maximum of 8 inches o.c.

3.7 PANEL APPLICATION METHODS

A. Single-Layer Application:

- 1. On ceilings, apply gypsum panels before wall/partition board application to the greatest extent possible and at right angles to framing, unless otherwise indicated.
- 2. On partitions/walls, apply gypsum panels vertically, unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.

- a. Stagger abutting end joints not less than one framing member in alternate courses of board.
3. On Z-furring members, apply gypsum panels vertically (parallel to framing) with no end joints. Locate edge joints over furring members.
- B. Single-Layer Fastening Methods: Apply gypsum panels to supports with steel drill screws.
- C. Water Resistant Gypsum Board:
 1. Water-Resistant Gypsum Board: Install at showers, toilets, janitor closets, mechanical and electrical rooms, non-conditioned spaces, and where indicated. Install with 1/4-inch gap where panels abut other construction or penetrations.
 2. Where tile backing panels abut other types of panels in the same plane, shim surfaces to produce a uniform plane across panel surfaces.

3.8 INSTALLING TRIM ACCESSORIES

- A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.

3.9 FINISHING GYPSUM BOARD ASSEMBLIES

- A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.
- B. Prefill open joints, rounded or beveled edges, and damaged surface areas.
- C. Apply joint tape over gypsum board joints, except those with trim having flanges not intended for tape.
- D. Gypsum Board Finish Levels: Finish panels to levels indicated below, according to ASTM C 840, for locations indicated:
 1. Level 1: Embed tape at joints in ceiling plenum areas, concealed areas, and where indicated, unless a higher level of finish is required for fire-resistance-rated assemblies and sound-rated assemblies.
 2. Level 2: Embed tape and apply separate first coat of joint compound to tape, fasteners, and trim flanges where panels are substrate for tile and where indicated panels are substrate for acoustical tile indicated.
 3. Level 4: Embed tape and apply separate first, fill, and finish coats of joint compound to tape, fasteners, and trim flanges at panel surfaces that will be exposed to view, unless otherwise indicated.

3.10 FIELD QUALITY CONTROL

- A. Above-Ceiling Observation: Before Contractor installs gypsum board ceilings, Design Professional will conduct an above-ceiling observation and report deficiencies in the Work observed. Do not proceed with installation of gypsum board to ceiling support framing until deficiencies have been corrected.
1. Notify Design Professional seven days in advance of date and time when Project, or part of Project, will be ready for above-ceiling observation.
 2. Before notifying Design Professional, complete the following in areas to receive gypsum board ceilings:
 - a. Installation of 80 percent of lighting fixtures, powered for operation.
 - b. Installation, insulation, and leak and pressure testing of water piping systems.
 - c. Installation of air-duct systems.
 - d. Installation of air devices.
 - e. Installation of mechanical system control-air tubing.
 - f. Installation of ceiling support framing.

END OF SECTION 092900

SECTION 093000 - TILING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

1. Ceramic tile.
2. Stone thresholds.
3. Waterproof membrane.
4. Crack isolation membrane.
5. Metal edge strips.

- B. Related Sections:

1. Section 079200 "Joint Sealants" for sealing of expansion, contraction, control, and isolation joints in tile surfaces.

1.3 DEFINITIONS

- A. General: Definitions in the ANSI A108 series of tile installation standards and in ANSI A137.1 apply to Work of this Section unless otherwise specified.
- B. ANSI A108 Series: ANSI A108.01, ANSI A108.02, ANSI A108.1A, ANSI A108.1B, ANSI A108.1C, ANSI A108.4, ANSI A108.5, ANSI A108.6, ANSI A108.8, ANSI A108.9, ANSI A108.10, ANSI A108.11, ANSI A108.12, ANSI A108.13, ANSI A108.14, ANSI A108.15, ANSI A108.16, and ANSI A108.17, which are contained in "American National Standard Specifications for Installation of Ceramic Tile."
- C. Module Size: Actual tile size plus joint width indicated.
- D. Face Size: Actual tile size, excluding spacer lugs.

1.4 PERFORMANCE REQUIREMENTS

- A. Static Coefficient of Friction: For tile installed on walkway surfaces, provide products with the values as determined by testing identical products per ASTM C 1028:

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Show locations of each type of tile and tile pattern. Show widths, details, and locations of expansion, contraction, control, and isolation joints in tile substrates and finished tile surfaces.
- C. Samples for Initial Selection: For each type of tile and grout indicated. Include Samples of accessories involving color selection.
- D. Samples for Verification:
 - 1. Full-size units of each type and composition of tile and for each color and finish required.
 - 2. Assembled samples mounted on a rigid panel, with grouted joints, for each type and composition of tile and for each color and finish required. Make samples at least 12 inches square, but not fewer than 4 tiles. Use grout of type and in color or colors approved for completed Work.
 - 3. Full-size units of each type of trim and accessory for each color and finish required.
 - 4. Stone thresholds in 6-inch lengths.
 - 5. Metal edge strips in 6-inch lengths.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Master Grade Certificates: For each shipment, type, and composition of tile, signed by tile manufacturer and Installer.
- C. Product Certificates: For each type of product, signed by product manufacturer.
- D. Material Test Reports: For each tile-setting and -grouting product and special purpose tile.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match and are from same production runs as products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Tile and Trim Units: Furnish quantity of full-size units equal to 3 percent of amount installed for each type, composition, color, pattern, and size indicated.
 - 2. Grout: Furnish quantity of grout equal to 3 percent of amount installed for each type, composition, and color indicated.

1.8 QUALITY ASSURANCE

- A. Source Limitations for Tile: Obtain tile of each type and color or finish from one source or producer.

1. Obtain tile of each type and color or finish from same production run and of consistent quality in appearance and physical properties for each contiguous area.
- B. Source Limitations for Setting and Grouting Materials: Obtain ingredients of a uniform quality for each mortar, adhesive, and grout component from one manufacturer and each aggregate from one source or producer.
- C. Source Limitations for Other Products: Obtain each of the following products specified in this Section from a single manufacturer for each product:
1. Stone thresholds.
 2. Waterproof membrane.
 3. Crack isolation membrane.
 4. Joint sealants.
 5. Metal edge strips.
- D. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
1. Build mockup of each type of floor tile installation.
 2. Build mockup of each type of wall tile installation.
 3. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
- E. Preinstallation Conference: Conduct conference at Project site.
1. Review requirements in ANSI A108.01 for substrates and for preparation by other trades.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use. Comply with requirements in ANSI A137.1 for labeling tile packages.
- B. Store tile and cementitious materials on elevated platforms, under cover, and in a dry location.
- C. Store aggregates where grading and other required characteristics can be maintained and contamination can be avoided.
- D. Store liquid materials in unopened containers and protected from freezing.
- E. Handle tile that has temporary protective coating on exposed surfaces to prevent coated surfaces from contacting backs or edges of other units. If coating does contact bonding surfaces of tile, remove coating from bonding surfaces before setting tile.

1.10 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install tile until construction in spaces is complete and ambient temperature and humidity conditions are maintained at the levels indicated in referenced standards and manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 PRODUCTS, GENERAL

- A. ANSI Ceramic Tile Standard: Provide tile that complies with ANSI A137.1 for types, compositions, and other characteristics indicated.
 - 1. Provide tile complying with Standard grade requirements unless otherwise indicated.
- B. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI A108.02, ANSI standards referenced in other Part 2 articles, ANSI standards referenced by TCA installation methods specified in tile installation schedules, and other requirements specified.
- C. FloorScore Compliance: Tile for floors shall comply with requirements of FloorScore Standard.
- D. Factory Blending: For tile exhibiting color variations within ranges, blend tile in factory and package so tile units taken from one package show same range in colors as those taken from other packages and match approved Samples.
- E. Mounting: For factory-mounted tile, provide back- or edge-mounted tile assemblies as standard with manufacturer unless otherwise indicated.
- F. Factory-Applied Temporary Protective Coating: Where indicated under tile type, protect exposed surfaces of tile against adherence of mortar and grout by precoating with continuous film of petroleum paraffin wax, applied hot. Do not coat unexposed tile surfaces.

2.2 TILE PRODUCTS

- A. Floor Tile and Base Tile.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. American Olean; Division of Dal-Tile International Inc.
 - b. Crossville, Inc.
 - c. Daltile; Division of Dal-Tile International Inc.
 - d. Deutsche Steinzeug America, Inc.
 - e. Interceramic.
 - f. Lone Star Ceramics Company.
 - g. Grupo Porcelanite.
 - h. Portobello America, Inc.
 - i. Seneca Tiles, Inc.
 - 2. Module Size: As indicated on drawings.
 - 3. Tile Color and Pattern: As indicated on drawings.
 - 4. Grout Color: As indicated on drawings.
 - 5. Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable and matching characteristics of adjoining flat tile. Provide shapes as follows, selected from manufacturer's standard shapes:

B. Wall Tile:

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. American Marazzi Tile, Inc.
 - b. American Olean; Division of Dal-Tile International Inc.
 - c. Daltile; Division of Dal-Tile International Inc.
 - d. Deutsche Steinzeug America, Inc.
 - e. Florida Tile Industries, Inc.
 - f. Florim USA.
 - g. Laufen.
 - h. Grupo Porcelanite.
 - i. Portobello America, Inc.
 - j. Seneca Tiles, Inc.
 - k. United States Ceramic Tile Company.
2. Size: As indicated on drawings.
3. Tile Color and Pattern: As indicated on drawings.
4. Grout Color: As indicated by on drawings.
5. Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable and matching characteristics of adjoining flat tile.

2.3 THRESHOLDS

- A. General: Fabricate to sizes and profiles indicated or required to provide transition between adjacent floor finishes.
 1. Bevel edges at 1:2 slope, with lower edge of bevel aligned with or up to 1/16 inch above adjacent floor surface. Finish bevel to match top surface of threshold. Limit height of threshold to 1/2 inch or less above adjacent floor surface.
- B. Marble Thresholds: ASTM C 503, with a minimum abrasion resistance of [10] [12] per ASTM C 1353 or ASTM C 241 and with honed finish.
 1. Description: Uniform, fine- to medium-grained white stone with gray veining.

2.4 WATERPROOF MEMBRANE

- A. General: Manufacturer's standard product, selected from the following, that complies with ANSI A118.10 and is recommended by the manufacturer for the application indicated. Include reinforcement and accessories recommended by manufacturer.
- B. Fabric-Reinforced, Fluid-Applied Membrane: System consisting of liquid-latex rubber or elastomeric polymer and continuous fabric reinforcement.
 1. Products: Subject to compliance with requirements, provide one of the following:

- a. Boiardi Products; a QEP company; Elastiment 344 Reinforced Waterproofing and Anti-Fracture/Crack Suppression Membrane.
- b. Bonsal American; an Oldcastle company; B 6000 Waterproof Membrane with Glass Fabric.
- c. Bostik, Inc.; Hydroment Blacktop 90210.
- d. Custom Building Products; 9240 Waterproofing and Anti-Fracture Membrane.
- e. Laticrete International, Inc.; Laticrete 9235 Waterproof Membrane.
- f. MAPEI Corporation; Mapelastic HPG with MAPEI Fiberglass Mesh.
- g. Mer-Kote Products, Inc.; Hydro-Guard 2000.
- h. Summitville Tiles, Inc.; S-9000.
- i. KBRS ShowerSeal.

2.5 CRACK ISOLATION MEMBRANE

- A. General: Manufacturer's standard product, selected from the following, that complies with ANSI A118.12 for high performance and is recommended by the manufacturer for the application indicated. Include reinforcement and accessories recommended by manufacturer.
- B. Fabric-Reinforced, Fluid-Applied Membrane: System consisting of liquid-latex rubber or elastomeric polymer and fabric reinforcement.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Boiardi Products; a QEP company; Elastiment 344 Reinforced Waterproofing and Anti-Fracture/Crack Suppression Membrane.
 - b. Bonsal American; an Oldcastle company; B 6000 Waterproof Membrane with Glass Fabric.
 - c. Bostik, Inc.; Hydroment Blacktop 90210.
 - d. Custom Building Products; 9240 Waterproofing and Anti-Fracture Membrane.
 - e. Laticrete International, Inc.; Laticrete 9235 Waterproof Membrane.
 - f. MAPEI Corporation; Mapelastic HPG with MAPEI Fiberglass Mesh.
 - g. Mer-Kote Products, Inc.; Hydro-Guard 2000.
 - h. Summitville Tiles, Inc.; S-9000.
 - i. KBRS ShowerSeal.

2.6 SETTING MATERIALS

- A. Portland Cement Mortar (Thickset) Installation Materials: ANSI A108.02.
 - 1. Reinforcing Wire Fabric: Galvanized, welded wire fabric, 2 by 2 inches by 0.062-inch diameter; comply with ASTM A 185 and ASTM A 82 except for minimum wire size.
 - 2. Latex Additive: Manufacturer's standard acrylic resin or styrene-butadiene-rubber water emulsion, serving as replacement for part or all of gaging water, of type specifically recommended by latex-additive manufacturer for use with field-mixed portland cement and aggregate mortar bed.
- B. Latex-Portland Cement Mortar (Thin Set): ANSI A118.4.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Boiardi Products; a QEP company.
 - b. Bonsal American; an Oldcastle company.
 - c. Bostik, Inc.
 - d. C-Cure.
 - e. Custom Building Products.
 - f. Jamo Inc.
 - g. Laticrete International, Inc.
 - h. MAPEI Corporation.
 - i. Mer-Kote Products, Inc.
 - j. Southern Grouts & Mortars, Inc.
 - k. Summitville Tiles, Inc.
 - l. TEC; a subsidiary of H. B. Fuller Company.
2. Provide prepackaged, dry-mortar mix containing dry, redispersible, vinyl acetate or acrylic additive to which only water must be added at Project site.
3. For wall applications, provide mortar that complies with requirements for nonsagging mortar in addition to the other requirements in ANSI A118.4.

2.7 GROUT MATERIALS

- A. Water-Cleanable Epoxy Grout: ANSI A118.3, with a VOC content of 65 g/L or less when calculated according to 40 CFR 59, Subpart D.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Atlas Minerals & Chemicals, Inc.
 - b. Boiardi Products; a QEP company.
 - c. Bonsal American; an Oldcastle company.
 - d. Bostik, Inc.
 - e. C-Cure.
 - f. Custom Building Products.
 - g. Jamo Inc.
 - h. Laticrete International, Inc.
 - i. MAPEI Corporation.
 - j. Mer-Kote Products, Inc.
 - k. Southern Grouts & Mortars, Inc.
 - l. Summitville Tiles, Inc.
 - m. TEC; a subsidiary of H. B. Fuller Company.
 2. Provide product capable of withstanding continuous and intermittent exposure to temperatures of up to 140 deg F and 212 deg F, respectively, and certified by manufacturer for intended use.

2.8 ELASTOMERIC SEALANTS

- A. General: Provide sealants, primers, backer rods, and other sealant accessories that comply with the following requirements and with the applicable requirements in Section 079200 "Joint Sealants."
- B. Colors: Provide colors of exposed sealants to match colors of grout in tile adjoining sealed joints unless otherwise indicated.
- C. One-Part, Mildew-Resistant Silicone Sealant: ASTM C 920; Type S; Grade NS; Class 25; Uses NT, G, A, and, as applicable to nonporous joint substrates indicated, O; formulated with fungicide, intended for sealing interior ceramic tile joints and other nonporous substrates that are subject to in-service exposures of high humidity and extreme temperatures.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. DAP Inc.; 100 percent Silicone Kitchen and Bath Sealant.
 - b. Dow Corning Corporation; Dow Corning 786.
 - c. GE Silicones; a division of GE Specialty Materials; Sanitary 1700.
 - d. Laticrete International, Inc.; Latasil Tile & Stone Sealant.
 - e. Pecora Corporation; Pecora 898 Sanitary Silicone Sealant.
 - f. Tremco Incorporated; Tremsil 600 White.

2.9 MISCELLANEOUS MATERIALS

- A. Trowelable Underlayments and Patching Compounds: Latex-modified, portland cement-based formulation provided or approved by manufacturer of tile-setting materials for installations indicated.
- B. Metal Edge Strips: Angle or L-shape, height to match tile and setting-bed thickness, metallic or combination of metal and PVC or neoprene base, designed specifically for flooring applications; stainless-steel, ASTM A 666, 300 Series exposed-edge material.
- C. Temporary Protective Coating: Either product indicated below that is formulated to protect exposed surfaces of tile against adherence of mortar and grout; compatible with tile, mortar, and grout products; and easily removable after grouting is completed without damaging grout or tile.
 - 1. Petroleum paraffin wax, fully refined and odorless, containing at least 0.5 percent oil with a melting point of 120 to 140 deg F per ASTM D 87.
 - 2. Grout release in form of manufacturer's standard proprietary liquid coating that is specially formulated and recommended for use as temporary protective coating for tile.
- D. Tile Cleaner: A neutral cleaner capable of removing soil and residue without harming tile and grout surfaces, specifically approved for materials and installations indicated by tile and grout manufacturers.
- E. Grout Sealer: Manufacturer's standard product for sealing grout joints and that does not change color or appearance of grout.
 - 1. Products: Subject to compliance with requirements, provide one of the following:

- a. Bonsal American; an Oldcastle company; Grout Sealer.
- b. Bostik, Inc.; CeramaSeal Grout & Tile Sealer.
- c. C-Cure; Penetrating Sealer 978.
- d. Custom Building Products; Grout and Tile Sealer.
- e. Jamo Inc.; Penetrating Sealer.
- f. MAPEI Corporation; KER 003, Silicone Spray Sealer for Cementitious Tile Grout.
- g. Southern Grouts & Mortars, Inc.; Silicone Grout Sealer.
- h. Summitville Tiles, Inc.; SL-15, Invisible Seal Penetrating Grout and Tile Sealer.
- i. TEC; a subsidiary of H. B. Fuller Company; TA-256 Penetrating Silicone Grout Sealer.

2.10 MIXING MORTARS AND GROUT

- A. Mix mortars and grouts to comply with referenced standards and mortar and grout manufacturers' written instructions.
- B. Add materials, water, and additives in accurate proportions.
- C. Obtain and use type of mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures to produce mortars and grouts of uniform quality with optimum performance characteristics for installations indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of installed tile.
 - 1. Verify that substrates for setting tile are firm, dry, clean, free of coatings that are incompatible with tile-setting materials including curing compounds and other substances that contain soap, wax, oil, or silicone; and comply with flatness tolerances required by ANSI A108.01 for installations indicated.
 - 2. Verify that concrete substrates for tile floors installed with thin-set mortar comply with surface finish requirements in ANSI A108.01 for installations indicated.
 - a. Verify that surfaces that received a steel trowel finish have been mechanically scarified.
 - b. Verify that protrusions, bumps, and ridges have been removed by sanding or grinding.
 - 3. Verify that installation of grounds, anchors, recessed frames, electrical and mechanical units of work, and similar items located in or behind tile has been completed.
 - 4. Verify that joints and cracks in tile substrates are coordinated with tile joint locations; if not coordinated, adjust joint locations in consultation with Design Professional.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Fill cracks, holes, and depressions in concrete substrates for tile floors installed with thin-set mortar with trowelable leveling and patching compound specifically recommended by tile-setting material manufacturer.
- B. Where indicated, prepare substrates to receive waterproofing by applying a reinforced mortar bed that complies with ANSI A108.1A and is sloped 1/4 inch per foot toward drains.
- C. Blending: For tile exhibiting color variations, verify that tile has been factory blended and packaged so tile units taken from one package show same range of colors as those taken from other packages and match approved Samples. If not factory blended, either return to manufacturer or blend tiles at Project site before installing.
- D. Field-Applied Temporary Protective Coating: If indicated under tile type or needed to prevent grout from staining or adhering to exposed tile surfaces, precoat them with continuous film of temporary protective coating, taking care not to coat unexposed tile surfaces.

3.3 TILE INSTALLATION

- A. Comply with TCA's "Handbook for Ceramic Tile Installation" for TCA installation methods specified in tile installation schedules. Comply with parts of the ANSI A108 Series "Specifications for Installation of Ceramic Tile" that are referenced in TCA installation methods, specified in tile installation schedules, and apply to types of setting and grouting materials used.
 - 1. For the following installations, follow procedures in the ANSI A108 Series of tile installation standards for providing 95 percent mortar coverage:
 - a. Exterior tile floors.
 - b. Tile floors in wet areas.
 - c. Tile swimming pool decks.
 - d. Tile floors in laundries.
 - e. Tile floors composed of tiles 8 by 8 inches or larger.
 - f. Tile floors composed of rib-backed tiles.
- B. Extend tile work into recesses and under or behind equipment and fixtures to form complete covering without interruptions unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.
- C. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.
- D. Provide manufacturer's standard trim shapes where necessary to eliminate exposed tile edges.
- E. Jointing Pattern: Lay tile in grid pattern unless otherwise indicated. Lay out tile work and center tile fields in both directions in each space or on each wall area. Lay out tile work to

minimize the use of pieces that are less than half of a tile. Provide uniform joint widths unless otherwise indicated.

1. For tile mounted in sheets, make joints between tile sheets same width as joints within tile sheets so joints between sheets are not apparent in finished work.
2. Where adjoining tiles on floor, base, walls, or trim are specified or indicated to be same size, align joints.
3. Where tiles are specified or indicated to be whole integer multiples of adjoining tiles on floor, base, walls, or trim, align joints unless otherwise indicated.

F. Joint Widths: Unless otherwise indicated, install tile with the following joint widths:

1. Ceramic Floor Tile: 1/4 inch.
2. Wall Tile: 1/16 inch.

G. Lay out tile wainscots to dimensions indicated or to next full tile beyond dimensions indicated.

H. Expansion Joints: Provide expansion joints and other sealant-filled joints, including control, contraction, and isolation joints, where indicated. Form joints during installation of setting materials, mortar beds, and tile. Do not saw-cut joints after installing tiles.

1. Where joints occur in concrete substrates, locate joints in tile surfaces directly above them.
2. Prepare joints and apply sealants to comply with requirements in Section 079200 "Joint Sealants."

I. Stone Thresholds: Install stone thresholds in same type of setting bed as adjacent floor unless otherwise indicated.

1. At locations where mortar bed (thickset) would otherwise be exposed above adjacent floor finishes, set thresholds in latex-portland cement mortar (thin set).

J. Metal Edge Strips: Install where exposed edge of tile flooring meets carpet, wood, or other flooring that finishes flush with top of tile.

K. Grout Sealer: Apply grout sealer to grout joints according to grout-sealer manufacturer's written instructions. As soon as grout sealer has penetrated grout joints, remove excess sealer and sealer from tile faces by wiping with soft cloth.

3.4 WATERPROOFING INSTALLATION

A. Install waterproofing to comply with ANSI A108.13 and manufacturer's written instructions to produce waterproof membrane of uniform thickness and bonded securely to substrate.

B. Do not install tile or setting materials over waterproofing until waterproofing has cured and been tested to determine that it is watertight.

3.5 CRACK ISOLATION MEMBRANE INSTALLATION

- A. Install crack isolation membrane to comply with ANSI A108.17 and manufacturer's written instructions to produce membrane of uniform thickness and bonded securely to substrate.
- B. Do not install tile or setting materials over crack isolation membrane until membrane has cured.

3.6 CLEANING AND PROTECTING

- A. Cleaning: On completion of placement and grouting, clean all ceramic tile surfaces so they are free of foreign matter.
 - 1. Remove epoxy and latex-portland cement grout residue from tile as soon as possible.
 - 2. Clean grout smears and haze from tile according to tile and grout manufacturer's written instructions but no sooner than 10 days after installation. Use only cleaners recommended by tile and grout manufacturers and only after determining that cleaners are safe to use by testing on samples of tile and other surfaces to be cleaned. Protect metal surfaces and plumbing fixtures from effects of cleaning. Flush surfaces with clean water before and after cleaning.
 - 3. Remove temporary protective coating by method recommended by coating manufacturer and that is acceptable to tile and grout manufacturer. Trap and remove coating to prevent drain clogging.
- B. Protect installed tile work with kraft paper or other heavy covering during construction period to prevent staining, damage, and wear. If recommended by tile manufacturer, apply coat of neutral protective cleaner to completed tile walls and floors.
- C. Prohibit foot and wheel traffic from tiled floors for at least seven days after grouting is completed.
- D. Before final inspection, remove protective coverings and rinse neutral protective cleaner from tile surfaces.

3.7 INTERIOR TILE INSTALLATION SCHEDULE

- A. Interior Floor Installations, Concrete Subfloor:
 - 1. Tile Installation F115: Thin-set mortar; epoxy grout; TCA F115.
 - a. Tile Type: As indicated on drawings.
 - b. Thin-Set Mortar: Latex-portland cement mortar.
 - c. Grout: Water-cleanable epoxy grout, or sand-portland cement.
- B. Interior Wall Installations, Masonry or Concrete:
 - 1. Tile Installation W202: Thin-set mortar; TCA W202.
 - a. Thin-Set Mortar: Latex-portland cement mortar.

- b. Grout: Water-cleanable epoxy grout.
2. Tile Installation W244: Thin-set mortar on cementitious backer units or fiber cement underlayment; TCA W244.
- a. Tile Type: As indicated on drawings.
 - b. Thin-Set Mortar: Latex-portland cement mortar.
 - c. Grout: Water-cleanable epoxy grout, or sand-portland cement.

END OF SECTION 093000

SECTION 095113 - ACOUSTICAL PANEL CEILINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes acoustical panels and exposed suspension systems for ceilings.
- B. Products furnished, but not installed under this Section, include anchors, clips, and other ceiling attachment devices to be cast in concrete at ceilings.

1.3 DEFINITIONS

- A. AC: Articulation Class.
- B. CAC: Ceiling Attenuation Class.
- C. LR: Light Reflectance coefficient.
- D. NRC: Noise Reduction Coefficient.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Coordinate Drawings: Reflected ceiling plans drawn to scale and coordinating penetrations and ceiling-mounted items. Show the following:
 - 1. Ceiling suspension members.
 - 2. Method of attaching hangers to building structure.
 - a. Furnish layouts for cast-in-place anchors, clips, and other ceiling attachment devices whose installation is specified in other Sections.
 - 3. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
 - 4. Minimum Drawing Scale: 1/8 inch = 1 foot.
- C. Samples for Initial Selection: For components with factory-applied color finishes.

- D. Samples for Verification: For each component indicated and for each exposed finish required, prepared on Samples of size indicated below.
 - 1. Acoustical Panel: Set of 6-inch- square Samples of each type, color, pattern, and texture.
 - 2. Exposed Suspension System Members, Moldings, and Trim: Set of 12-inch- long Samples of each type, finish, and color.
- E. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each acoustical panel ceiling.
- F. Maintenance Data: For finishes to include in maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain each type of acoustical ceiling panel and supporting suspension system through one source from a single manufacturer.
 - 1. Surface-Burning Characteristics: Provide acoustical panels with the following surface-burning characteristics complying with ASTM E 1264 for Class A, B, C materials as determined by testing identical products per ASTM E 84:
 - a. Smoke-Developed Index: 450 or less.
- B. Seismic Standard: Provide acoustical panel ceilings designed and installed to withstand the effects of earthquake motions according to the following:
 - 1. Standard for Ceiling Suspension Systems Requiring Seismic Restraint: Comply with ASTM E 580.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver acoustical panels, suspension system components, and accessories to Project site in original, unopened packages and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.
- B. Before installing acoustical panels, permit them to reach room temperature and a stabilized moisture content.
- C. Handle acoustical panels carefully to avoid chipping edges or damaging units in any way.

1.7 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install acoustical panel ceilings until spaces are enclosed and weatherproof, wet work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

1. Pressurized Plenums: Operate ventilation system for not less than 48 hours before beginning acoustical panel ceiling installation.

1.8 COORDINATION

- A. Coordinate layout and installation of acoustical panels and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

1.9 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Acoustical Ceiling Panels: Full-size panels equal to 2.0 percent of quantity installed.
 2. Suspension System Components: Quantity of each exposed component equal to 2.0 percent of quantity installed.
 3. Hold-Down Clips: Equal to 2.0 percent of amount installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply for product selection:
 1. Products: Subject to compliance with requirements, provide one of the products specified.
 2. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 ACOUSTICAL PANELS, GENERAL

- A. Acoustical Panel Standard: Provide manufacturer's standard panels of configuration indicated that comply with ASTM E 1264 classifications as designated by types, patterns, acoustical ratings, and light reflectances, unless otherwise indicated.
 1. Mounting Method for Measuring NRC: Type E-400; plenum mounting in which face of test specimen is 15-3/4 inches away from test surface per ASTM E 795.
- B. Acoustical Panel Colors and Patterns: Match appearance characteristics indicated for each product type.
 1. Where appearance characteristics of acoustical panels are indicated by referencing pattern designations in ASTM E 1264 and not manufacturers' proprietary product designations, provide products selected by Design Professional from each manufacturer's full range that

comply with requirements indicated for type, pattern, color, light reflectance, acoustical performance, edge detail, and size.

2.3 WATER-FELTED, MINERAL-BASE ACOUSTICAL PANELS FOR ACOUSTICAL PANEL CEILING

- A. Products similar to Armstrong Calla 2820, ACT-1.
1. Classification: Provide panels complying with ASTM E 1264 for Type IV, mineral base with painted finish; Form 2, water felted; and pattern as follows:
 2. Pattern: E.
 3. Color: White
 4. LR: Not less than 0.80.
 5. NRC: Not less than 0.85.
 6. CAC: Not less than 35.
 7. Edge Detail: Square.
 8. Thickness: 1 inch.
 9. Size 24 inches by 24 inches
 10. Location: All locations, unless noted otherwise, see drawings.
 11. Additional manufacturers: USG and Certainteed.

2.4 METAL SUSPENSION SYSTEMS, GENERAL

- A. Metal Suspension System Standard: Provide manufacturer's standard direct-hung metal suspension systems of types, structural classifications, and finishes indicated that comply with applicable requirements in ASTM C 635.
- B. Finishes and Colors, General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes. Provide manufacturer's standard factory-applied finish for type of system indicated.
1. High-Humidity Finish: Comply with ASTM C 635 requirements for "Coating Classification for Severe Environment Performance" where high-humidity finishes are indicated.
- C. Attachment Devices: Size for five times the design load indicated in ASTM C 635, Table 1, "Direct Hung," unless otherwise indicated.
- D. Wire Hangers, Braces, and Ties: Provide wires complying with the following requirements:

1. Zinc-Coated Carbon-Steel Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper.
 2. Size: Select wire diameter so its stress at three times hanger design load (ASTM C 635, Table 1, "Direct Hung") will be less than yield stress of wire, but provide not less than 0.135-inch- diameter wire.
- E. Hanger Rods and Flat Hangers: Mild steel, zinc coated or protected with rust-inhibitive paint.
- F. Angle Hangers: Angles with legs not less than 7/8 inch wide; formed with 0.04-inch- thick, galvanized steel sheet complying with ASTM A 653/A 653M, coating designation; with bolted connections and 5/16-inch- diameter bolts.
- G. Seismic Struts: Manufacturer's standard compression struts designed to accommodate seismic forces.
- H. Seismic Clips: Manufacturer's standard seismic clips designed and spaced to secure acoustical panels in-place.

2.5 METAL SUSPENSION SYSTEM FOR ACOUSTICAL PANEL CEILING

- A. Products similar to Armstrong Prelude 15/16”:
- B. Wide-Face, Capped, Double-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet, pre-painted, electrolytically zinc coated, or hot-dip galvanized according to ASTM A 653/A 653M, not less than G30 coating designation, with pre-finished 15/16-inch- wide metal caps on flanges.
1. Structural Classification: Intermediate-duty system.
 2. End Condition of Cross Runners: Override (stepped) or butt-edge type.
 3. Face Design: Flat, flush.
 4. Cap Material: Steel or aluminum cold-rolled sheet.
 5. Cap Finish: Match adjacent ceiling tile.
- C. Additional Manufacturers:
1. Donn
 2. USG
 3. Certainteed
 4. Chicago Metallic Corporation

2.6 METAL EDGE MOLDINGS AND TRIM

- A. Manufacturers:
1. Armstrong World Industries, Inc.
 2. Celotex Corporation; Architectural Ceilings Marketing Dept.
 3. Chicago Metallic Corporation.
 4. Fry Reglet Corporation.
 5. Gordon, Inc.
 6. MM Systems, Inc.

7. USG Interiors, Inc.
- B. Roll-Formed Sheet-Metal Edge Moldings and Trim: Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations that fit acoustical panel edge details and suspension systems indicated; formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension system runners.
1. For lay-in panels with reveal edge details, provide stepped edge molding that forms reveal of same depth and width as that formed between edge of panel and flange at exposed suspension member.
 2. For circular penetrations of ceiling, provide edge moldings fabricated to diameter required to fit penetration exactly.
 3. For narrow-face suspension systems, provide suspension system and manufacturer's standard edge moldings that match width and configuration of exposed runners.
- C. Extruded-Aluminum Edge Moldings and Trim: Where indicated, provide manufacturer's extruded-aluminum edge moldings and trim of profile indicated or referenced by manufacturer's designations, including splice plates, corner pieces, and attachment and other clips, complying with the following requirements:
1. Aluminum Alloy: Alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with not less than the strength and durability properties of aluminum extrusions complying with ASTM B 221 for alloy and temper 6063-T5.
 2. Finish designations prefixed by AA comply with system established by the Aluminum Association for designating aluminum finishes.
 3. Baked-Enamel Finish: AA-C12C42R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: acid-chromate-fluoride-phosphate conversion coating; Organic Coating: as specified below). Apply baked enamel complying with paint manufacturer's written instructions for cleaning, conversion coating, and painting.
 - a. Organic Coating: Thermosetting, primer/topcoat system with a minimum dry film thickness of 0.8 to 1.2 mils.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, including structural framing to which acoustical panel ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and with requirements for installation tolerances and other conditions affecting performance of acoustical panel ceilings.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Measure each ceiling area and establish layout of acoustical panels to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width panels at borders, and comply with layout shown on reflected ceiling plans.

3.3 INSTALLATION, GENERAL

- A. General: Install acoustical panel ceilings to comply with ASTM C 636 and seismic requirements indicated, per manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."
- B. Suspend ceiling hangers from building's structural members and as follows:
 - 1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
 - 2. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, counter-splaying, or other equally effective means.
 - 3. Splay hangers only where required and, if permitted with fire-resistance-rated ceilings, to miss obstructions; offset resulting horizontal forces by bracing, counter-splaying, or other equally effective means.
 - 4. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.
 - 5. Secure wire hangers to ceiling suspension members and to supports above with a minimum of three tight turns. Connect hangers directly either to structures or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
 - 6. Secure flat, angle, channel, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are secure and appropriate for both structure to which hangers are attached and type of hanger involved. Install hangers in a manner that will not cause them to deteriorate or fail due to age, corrosion, or elevated temperatures.
 - 7. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, post-installed mechanical or adhesive anchors, or power-actuated fasteners that extend through forms into concrete.
 - 8. Do not attach hangers to steel deck tabs.
 - 9. Do not attach hangers to steel roof deck. Attach hangers to structural members.
 - 10. Space hangers not more than 48 inches o.c. along each member supported directly from hangers, unless otherwise indicated; provide hangers not more than 8 inches from ends of each member.
- C. Secure bracing wires to ceiling suspension members and to supports with a minimum of four tight turns. Suspend bracing from building's structural members as required for hangers, without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or post-installed anchors.

- D. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels.
 - 1. Screw attach moldings to substrate at intervals not more than 16 inches o.c. and not more than 3 inches from ends, leveling with ceiling suspension system to a tolerance of 1/8 inch in 12 feet. Miter corners accurately and connect securely.
 - 2. Do not use exposed fasteners, including pop rivets, on moldings and trim.
- E. Install suspension system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.
- F. Install acoustical panels with undamaged edges and fit accurately into suspension system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide a neat, precise fit.
 - 1. Arrange directionally patterned acoustical panels as follows:
 - a. As indicated on reflected ceiling plans.
 - b. Install panels in a basket-weave pattern.
 - 2. For square-edged panels, install panels with edges fully hidden from view by flanges of suspension system runners and moldings.
 - 3. Paint cut edges of panel remaining exposed after installation; match color of exposed panel surfaces using coating recommended in writing for this purpose by acoustical panel manufacturer.
 - 4. Install hold-down clips in areas indicated and for fire-resistance ratings; space as recommended by panel manufacturer's written instructions, unless otherwise indicated.
 - 5. Protect lighting fixtures and air ducts to comply with requirements indicated for fire-resistance-rated assembly.

3.4 CLEANING

- A. Clean exposed surfaces of acoustical panel ceilings, including trim, edge moldings, and suspension system members. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION 095113

SECTION 096519 - RESILIENT FLOOR TILE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Luxury vinyl floor tile.
 - 2. Resilient wall base and accessories.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples for Initial Selection: For each type of product indicated.
- C. Samples for Verification: Full-size units of each color and pattern of resilient floor tile required.
 - 1. Resilient Wall Base and Accessories: Manufacturer's standard-size Samples, but not less than 12 inches long, of each resilient product color and pattern required.
- D. Maintenance Data: For resilient products to include in maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Fire-Test-Response Characteristics: Provide products identical to those tested for fire-exposure behavior per test method indicated by a testing and inspecting agency acceptable to authorities having jurisdiction.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store resilient products and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F or more than 90 deg F. Store tiles on flat surfaces.

1.6 PROJECT CONDITIONS

- A. Maintain temperatures within range recommended by manufacturer, but not less than 70 deg F or more than 95 deg F, in spaces to receive floor tile during the following time periods:
 - 1. 48 hours before installation.
 - 2. During installation.
 - 3. 48 hours after installation.
- B. After post-installation period, maintain temperatures within range recommended by manufacturer, but not less than 55 deg F or more than 95 deg F.
- C. Close spaces to traffic during floor covering installation.
- D. Close spaces to traffic for 48 hours after floor covering installation.
- E. Install resilient products after other finishing operations, including painting, have been completed.
- F. Coordinate with specification section 024119 "Selective Demolition" for removal of existing floor coverings.
- G. Warranty: Manufacturer's standard 20-year limited warranty.

1.7 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Floor Tile: Furnish 1 box for every 50 boxes or fraction thereof, of each type, color, and pattern of floor tile installed.
 - 2. Resilient Wall Base and Accessories: Furnish not less than 10 linear feet for every 500 linear feet or fraction thereof, of each type, color, pattern, and size of resilient product installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide one of the products listed in other Part 2 articles.

2.2 COLORS AND PATTERNS

- A. Colors and Patterns: Indicated on drawings.

2.3 RESILIENT WALL BASE

- A. Wall Base: ASTM F 1861.
 - 1. Armstrong World Industries, Inc.
 - 2. Azrock Commercial Flooring, DOMCO.
 - 3. Tarkette.
 - 4. Marley Flexco (USA), Inc.
 - 5. Roppe Corporation. (Basis of Design as indicated in Drawings).
- B. Type (Material Requirement): TV (vinyl), TS (rubber, vulcanized thermoset), TP (rubber, thermoplastic).
- C. Group (Manufacturing Method): I (solid, homogeneous).
- D. Style: Cove (with top-set toe).
- E. Minimum Thickness: 0.125 inch.
- F. Height: 4 inches.
- G. Lengths: Coils in manufacturer's standard length.
- H. Outside Corners: Premolded.
- I. Inside Corners: Premolded.
- J. Surface: Smooth.

2.4 RESILIENT MOLDING ACCESSORY

- A. Description: Reducer strip for resilient floor covering. Joiner for tile edges and carpet edges.
 - 1. Tarkette.
 - 2. Marley Flexco (USA), Inc.
 - 3. Roppe Corporation.
- B. Material: Vinyl or Rubber.
- C. Profile and Dimensions: Manufacturer's standard.

2.5 INSTALLATION MATERIALS

- A. Trowelable Leveling and Patching Compounds: Latex-modified, portland cement based or blended hydraulic cement based formulation provided or approved by resilient product manufacturer for applications indicated.
- B. Adhesives: Water-resistant type recommended by manufacturer to suit resilient products and substrate conditions indicated.
 - 1. Use adhesives that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):

- a. VCT and Asphalt Tile Adhesives: 50 g/L.
 - b. Cove Base Adhesives: 50 g/L.
 - c. Rubber Floor Adhesives: 60 g/L.
- C. Metal Edge Strips: Extruded aluminum with mill finish of width shown, of height required to protect exposed edges of tiles, and in maximum available lengths to minimize running joints.

2.6 LUXURY VINYL FLOOR TILE

- A. Products: Subject to compliance with requirements, provide products by one of the following:
- 1. Mannington.
 - 2. Armstrong World Industries, Inc.
 - 3. Tarkett Company (Basis of Design as indicated in Drawings).
 - 4. Roppe Corporation, USA.
 - 5. Mohawk
 - 6. Shaw Contract.
- B. Tile Standard: ASTM F 1700.
- 1. Class: 3.
 - 2. Type: B.
- C. Thickness: 3mm.
- D. Size: See Drawings.
- E. Colors and Patterns: See Drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, with Installer present, for compliance with requirements for installation tolerances, moisture content, and other conditions affecting performance.
- 1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resilient products.
 - 2. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Prepare substrates according to manufacturer's written recommendations to ensure adhesion of resilient products.
- B. Concrete Substrates: Prepare according to ASTM F 710.

1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
 2. Alkalinity and Adhesion Testing: Perform tests recommended by manufacturer. Proceed with installation only after substrates pass testing.
 3. Moisture Testing:
 - a. Perform anhydrous calcium chloride test, ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 95% RH/1000 sq. ft. in 24 hours.
 - b. Perform tests recommended by manufacturer. Proceed with installation only after substrates pass testing.
- C. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.
- D. Use trowelable leveling and patching compound to fill cracks, holes, and depressions in substrates.
- E. Move resilient products and installation materials into spaces where they will be installed at least 48 hours in advance of installation.
1. Do not install resilient products until they are same temperature as space where they are to be installed.
- F. Sweep and vacuum clean substrates to be covered by resilient products immediately before installation. After cleaning, examine substrates for moisture, alkaline salts, carbonation, and dust. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 LVT TILE INSTALLATION

- A. Lay out tiles from center marks established with principal walls, discounting minor offsets, so tiles at opposite edges of room are of equal width. Adjust as necessary to avoid using cut widths that equal less than one-half tile at perimeter.
- B. Match tiles for color and pattern by selecting tiles from cartons in the same sequence as manufactured and packaged, if so numbered. Discard broken, cracked, chipped, or deformed tiles.
- C. Scribe, cut, and fit tiles to butt neatly and tightly to vertical surfaces and permanent fixtures including built-in furniture, cabinets, pipes, outlets, edgings, door frames, thresholds, and nosings.
- D. Extend tiles into toe spaces, door reveals, closets, and similar openings.
- E. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on floor tiles as marked on substrates. Use chalk or other nonpermanent, nonstaining marking device.

- F. Install tiles on covers for telephone and electrical ducts and similar items in finished floor areas. Maintain overall continuity of color and pattern with pieces of tile installed on covers. Tightly adhere tile edges to substrates that abut covers and to cover perimeters.
- G. Adhere tiles to flooring substrates using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.

3.4 RESILIENT WALL BASE INSTALLATION

- A. Apply wall base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.
- B. Install wall base in lengths as long as practicable without gaps at seams and with tops of adjacent pieces aligned.
- C. Tightly adhere wall base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.
- D. Do not stretch wall base during installation.
- E. Premolded Corners: Install premolded corners before installing straight pieces.

3.5 RESILIENT ACCESSORY INSTALLATION

- A. Resilient Molding Accessories: Butt to adjacent materials and tightly adhere to substrates throughout length of each piece. Install reducer strips at edges of floor coverings that would otherwise be exposed.

3.6 CLEANING AND PROTECTION

- A. Perform the following operations immediately after completing resilient product installation:
 - 1. Remove adhesive and other blemishes from exposed surfaces.
 - 2. Sweep and vacuum surfaces thoroughly.
 - 3. Damp-mop surfaces to remove marks and soil.
 - a. Do not wash surfaces until after time period recommended by manufacturer.
- B. Protect resilient products from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period. Use protection methods recommended in writing by manufacturer.
 - 1. Cover products installed on horizontal surfaces with undyed, untreated building paper until Substantial Completion.
 - 2. Do not move heavy and sharp objects directly over surfaces. Place hardboard or plywood panels over flooring and under objects while they are being moved. Slide or roll objects over panels without moving panels.

END OF SECTION 096519

SECTION 099113 - EXTERIOR PAINTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes surface preparation and the application of paint systems on the following exterior substrates:
 - 1. Concrete masonry units (CMU).
 - 2. Steel.
 - 3. Galvanized metal.
 - 4. Aluminum (not anodized or otherwise coated).
- B. Related Sections include the following:
 - 1. Division 5 Sections for shop priming of metal substrates with primers specified in this Section.
 - 2. Division 9 Section "Interior Painting" for surface preparation and the application of paint systems on interior substrates.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples for Initial Selection: For each type of topcoat product indicated.
- C. Samples for Verification: For each type of paint system and each color and gloss of topcoat indicated.
 - 1. Submit Samples on rigid backing, 8 inches square.
 - 2. Step coats on Samples to show each coat required for system.
 - 3. Label each coat of each Sample.
 - 4. Label each Sample for location and application area.
- D. Product List: For each product indicated, include the following:
 - 1. Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules.
 - 2. Printout of current "MPI Approved Products List" for each product category specified in Part 2, with the proposed product highlighted.

1.4 QUALITY ASSURANCE

A. MPI Standards:

1. Products: Complying with MPI standards indicated and listed in "MPI Approved Products List."
2. Preparation and Workmanship: Comply with requirements in "MPI Architectural Painting Specification Manual" for products and paint systems indicated.

B. Mockups: Apply benchmark samples of each paint system indicated and each color and finish selected to verify preliminary selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Design Professional will select one surface to represent surfaces and conditions for application of each paint system specified in Part 3.
 - a. Vertical and Horizontal Surfaces: Provide samples of at least 100 sq. ft..
 - b. Other Items: Design Professional will designate items or areas required.
2. Final approval of color selections will be based on benchmark samples.
 - a. If preliminary color selections are not approved, apply additional benchmark samples of additional colors selected by Design Professional at no added cost to Owner.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.

1. Maintain containers in clean condition, free of foreign materials and residue.
2. Remove rags and waste from storage areas daily.

1.6 PROJECT CONDITIONS

A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F.

B. Do not apply paints in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.

1.7 EXTRA MATERIALS

A. Furnish extra materials described below that are from same production run (batch mix) as materials applied and that are packaged for storage and identified with labels describing contents.

1. Quantity: Furnish an additional 5 percent, but not less than 1 gal. of each material and color applied.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Benjamin Moore & Co.
 - 2. ICI Paints.
 - 3. PPG Architectural Finishes, Inc.
 - 4. Sherwin-Williams Company (The).

2.2 PAINT, GENERAL

- A. Material Compatibility:
 - 1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
 - 2. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.
- B. Colors: As selected by Design Professional from manufacturer's full range.

2.3 BLOCK FILLERS

- A. Interior/Exterior Latex Block Filler: MPI #4.
 - 1. VOC Content: E Range of E2.

2.4 PRIMERS/SEALERS

- A. Alkali-Resistant Primer: MPI #3.
 - 1. VOC Content: E Range of E1.
- B. Bonding Primer (Water Based): MPI #17.
 - 1. VOC Content: E Range of E1.

2.5 METAL PRIMERS

- A. Alkyd Anticorrosive Metal Primer: MPI #79.
 - 1. VOC Content: E Range of E1.
- B. Cementitious Galvanized-Metal Primer: MPI #26.

1. VOC Content: E Range of E1.
- C. Quick-Drying Primer for Aluminum: MPI #95.
1. VOC Content: E Range of E1.

2.6 EXTERIOR LATEX PAINTS

- A. Exterior Latex (Flat): MPI #10 (Gloss Level 1).
1. VOC Content: E Range of E1.
- B. Exterior Latex (Semigloss): MPI #11 (Gloss Level 5).
1. VOC Content: E Range of E1.

2.7 EXTERIOR ALKYD PAINTS

- A. Exterior Alkyd Enamel (Semigloss): MPI #94 (Gloss Level 5).
1. VOC Content: E Range of E1.

2.8 ALUMINUM PAINT

- A. Aluminum Paint: MPI #1.
1. VOC Content: E Range of E1 E2 E3.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of work.
- B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
1. Masonry (Clay and CMU): 12 percent.
- C. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.
- D. Begin coating application only after unsatisfactory conditions have been corrected and surfaces are dry.

1. Beginning coating application constitutes Contractor's acceptance of substrates and conditions.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates and paint systems indicated.
- B. Remove plates, machined surfaces, and similar items already in place that are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
 1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.
 2. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
- C. Clean substrates of substances that could impair bond of paints, including dirt, oil, grease, and incompatible paints and encapsulants.
 1. Remove incompatible primers and reprime substrate with compatible primers as required to produce paint systems indicated.
- D. Concrete Masonry Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.
- E. Steel Substrates: Remove rust and loose mill scale. Clean using methods recommended in writing by paint manufacturer.
- F. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal fabricated from coil stock by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.
- G. Aluminum Substrates: Remove surface oxidation.

3.3 APPLICATION

- A. Apply paints according to manufacturer's written instructions.
 1. Use applicators and techniques suited for paint and substrate indicated.
 2. Paint surfaces behind movable items same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed items with prime coat only.
 3. All exposed, unfinished surfaces are to be painted.
- B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Tint undercoats to match color of topcoat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.

- C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.
- D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

3.4 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
- B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Design Professional, and leave in an undamaged condition.
- D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.5 EXTERIOR PAINTING SCHEDULE

- A. CMU Substrates:
 - 1. Latex System: MPI EXT 4.2A.
 - a. Prime Coat: Interior/exterior latex block filler.
 - b. Intermediate Coat: Exterior latex matching topcoat.
 - c. Topcoat: Exterior latex (flat).
- B. Steel Substrates:
 - 1. Alkyd System: MPI EXT 5.1D.
 - a. Prime Coat: Alkyd anticorrosive metal primer.
 - b. Intermediate Coat: Exterior alkyd enamel matching topcoat.
 - c. Topcoat: Exterior alkyd enamel (semigloss).
- C. Galvanized-Metal Substrates:
 - 1. Alkyd System: MPI EXT 5.3B.
 - a. Prime Coat: Cementitious galvanized-metal primer.
 - b. Intermediate Coat: Exterior alkyd enamel matching topcoat.
 - c. Topcoat: Exterior alkyd enamel (semigloss).
- D. Aluminum Substrates:

1. Alkyd System: MPI EXT 5.4F.
 - a. Prime Coat: Quick-drying primer for aluminum.
 - b. Intermediate Coat: Exterior alkyd enamel matching topcoat.
 - c. Topcoat: Exterior alkyd enamel (semigloss).

END OF SECTION 099113

SECTION 099123 - INTERIOR PAINTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes surface preparation and the application of paint systems on the following interior substrates:
 - 1. Concrete.
 - 2. Concrete masonry units (CMU).
 - 3. Steel.
 - 4. Galvanized metal.
 - 5. Aluminum (not anodized or otherwise coated).
 - 6. Gypsum board.
- B. Related Sections include the following:
 - 1. Division 5 Sections for shop priming of metal substrates with primers specified in this Section.
 - 2. Division 9 Section "Exterior Painting" for surface preparation and the application of paint systems on exterior substrates.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples for Initial Selection: For each type of topcoat product indicated.
- C. Samples for Verification: For each type of paint system and in each color and gloss of topcoat indicated.
 - 1. Submit Samples on rigid backing, 8 inches square.
 - 2. Step coats on Samples to show each coat required for system.
 - 3. Label each coat of each Sample.
 - 4. Label each Sample for location and application area.
- D. Product List: For each product indicated, include the following:
 - 1. Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules.

2. Printout of current "MPI Approved Products List" for each product category specified in Part 2, with the proposed product highlighted.

1.4 QUALITY ASSURANCE

A. MPI Standards:

1. Products: Complying with MPI standards indicated and listed in "MPI Approved Products List."
2. Preparation and Workmanship: Comply with requirements in "MPI Architectural Painting Specification Manual" for products and paint systems indicated.

B. Mockups: Apply benchmark samples of each paint system indicated and each color and finish selected to verify preliminary selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Design Professional will select one surface to represent surfaces and conditions for application of each paint system specified in Part 3.
 - a. Wall and Ceiling Surfaces: Provide samples of at least 100 sq. ft.
 - b. Other Items: Design Professional will designate items or areas required.
2. Apply benchmark samples after permanent lighting and other environmental services have been activated.
3. Final approval of color selections will be based on benchmark samples.
 - a. If preliminary color selections are not approved, apply additional benchmark samples of additional colors selected by Design Professional at no added cost to Owner.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.

1. Maintain containers in clean condition, free of foreign materials and residue.
2. Remove rags and waste from storage areas daily.

1.6 PROJECT CONDITIONS

A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F.

B. Do not apply paints when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.

1.7 EXTRA MATERIALS

- A. Furnish extra materials described below that are from same production run (batch mix) as materials applied and that are packaged for storage and identified with labels describing contents.
 - 1. Quantity: Furnish an additional 5 percent, but not less than 1 gal. of each material and color applied.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Benjamin Moore & Co.
 - 2. ICI Paints.
 - 3. PPG Architectural Finishes, Inc.
 - 4. Sherwin-Williams Company (The).

2.2 PAINT, GENERAL

- A. Material Compatibility:
 - 1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
 - 2. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.
- B. VOC Content of Field-Applied Interior Paints and Coatings: Provide products that comply with the following limits for VOC content, exclusive of colorants added to a tint base, when calculated according to 40 CFR 59, Subpart D (EPA Method 24); these requirements do not apply to paints and coatings that are applied in a fabrication or finishing shop:
 - 1. Flat Paints, Coatings, and Primers: VOC content of not more than 50 g/L.
 - 2. Nonflat Paints, Coatings, and Primers: VOC content of not more than 150 g/L.
 - 3. Anti-Corrosive and Anti-Rust Paints Applied to Ferrous Metals: VOC not more than 250 g/L.
 - 4. Floor Coatings: VOC not more than 100 g/L.
 - 5. Flat Topcoat Paints: VOC content of not more than 50 g/L.
 - 6. Nonflat Topcoat Paints: VOC content of not more than 150 g/L.
 - 7. Anti-Corrosive and Anti-Rust Paints Applied to Ferrous Metals: VOC not more than 250 g/L.
 - 8. Primers, Sealers, and Undercoaters: VOC content of not more than 200 g/L.
 - 9. Pre-Treatment Wash Primers: VOC content of not more than 420 g/L.

C. Chemical Components of Field-Applied Interior Paints and Coatings: Provide topcoat paints and anti-corrosive and anti-rust paints applied to ferrous metals that comply with the following chemical restrictions; these requirements do not apply to paints and coatings that are applied in a fabrication or finishing shop:

1. Aromatic Compounds: Paints and coatings shall not contain more than 1.0 percent by weight of total aromatic compounds (hydrocarbon compounds containing one or more benzene rings).
2. Restricted Components: Paints and coatings shall not contain any of the following:
 - a. Acrolein.
 - b. Acrylonitrile.
 - c. Antimony.
 - d. Benzene.
 - e. Butyl benzyl phthalate.
 - f. Cadmium.
 - g. Di (2-ethylhexyl) phthalate.
 - h. Di-n-butyl phthalate.
 - i. Di-n-octyl phthalate.
 - j. 1,2-dichlorobenzene.
 - k. Diethyl phthalate.
 - l. Dimethyl phthalate.
 - m. Ethylbenzene.
 - n. Formaldehyde.
 - o. Hexavalent chromium.
 - p. Isophorone.
 - q. Lead.
 - r. Mercury.
 - s. Methyl ethyl ketone.
 - t. Methyl isobutyl ketone.
 - u. Methylene chloride.
 - v. Naphthalene.
 - w. Toluene (methylbenzene).
 - x. 1,1,1-trichloroethane.
 - y. Vinyl chloride.

D. Colors: As selected by Design Professional from manufacturer's full range.

2.3 BLOCK FILLERS

A. Interior/Exterior Latex Block Filler: MPI #4.

1. VOC Content: E Range of E2.

2.4 PRIMERS/SEALERS

A. Interior Latex Primer/Sealer: MPI #50.

1. VOC Content: E Range of E1.
2. Environmental Performance Rating: EPR 1.

B. Interior Alkyd Primer/Sealer: MPI #45.

1. VOC Content: E Range of E1.

2.5 METAL PRIMERS

A. Quick-Drying Alkyd Metal Primer: MPI #76.

1. VOC Content: E Range of E1.

B. Cementitious Galvanized-Metal Primer: MPI #26.

1. VOC Content: E Range of E1.

C. Quick-Drying Primer for Aluminum: MPI #95.

1. VOC Content: E Range of E1.

2.6 LATEX PAINTS

A. Interior Latex (Eggshell): MPI #52 (Gloss Level 3).

1. VOC Content: E Range of E1.
2. Environmental Performance Rating: EPR 1.

B. Interior Latex (Semigloss): MPI #54 (Gloss Level 5).

1. VOC Content: E Range of E1.
2. Environmental Performance Rating: EPR 2.

2.7 ALKYD PAINTS

A. Interior Alkyd (Semigloss): MPI #47 (Gloss Level 5).

1. VOC Content: E Range of E1.
2. Environmental Performance Rating: EPR 1.

B. Interior Alkyd (Gloss): MPI #48 (Gloss Level 6).

1. VOC Content: E Range of E1.

2.8 FLOOR COATINGS

A. Interior Concrete Floor Stain: MPI #58.

1. VOC Content: E Range of **E1**.
2. Environmental Performance Rating: EPR 2.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of work.
- B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
 1. Concrete: 12 percent.
 2. Masonry (Clay and CMU): 12 percent.
 3. Gypsum Board: 12 percent.
- C. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.
- D. Begin coating application only after unsatisfactory conditions have been corrected and surfaces are dry.
 1. Beginning coating application constitutes Contractor's acceptance of substrates and conditions.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates indicated.
- B. Remove plates, machined surfaces, and similar items already in place that are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
 1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.
 2. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
- C. Clean substrates of substances that could impair bond of paints, including dirt, oil, grease, and incompatible paints and encapsulants.
 1. Remove incompatible primers and reprime substrate with compatible primers as required to produce paint systems indicated.

- D. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.
- E. Concrete Masonry Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.
- F. Steel Substrates: Remove rust and loose mill scale. Clean using methods recommended in writing by paint manufacturer.
- G. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal fabricated from coil stock by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.
- H. Aluminum Substrates: Remove surface oxidation.
- I. Gypsum Board Substrates: Do not begin paint application until finishing compound is dry and sanded smooth.

3.3 APPLICATION

- A. Apply paints according to manufacturer's written instructions.
 - 1. Use applicators and techniques suited for paint and substrate indicated.
 - 2. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
 - 3. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
- B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Tint undercoats to match color of topcoat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.
- C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.
- D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.
- E. Painting Mechanical and Electrical Work: Paint items exposed in equipment rooms and occupied spaces including, but not limited to, the following:
 - 1. Mechanical Work:
 - a. Uninsulated metal piping.
 - b. Uninsulated plastic piping.

- c. Pipe hangers and supports.
- d. Tanks that do not have factory-applied final finishes.
- e. Visible portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets.
- f. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
- g. Mechanical equipment that is indicated to have a factory-primed finish for field painting.

2. Electrical Work:

- a. Electrical equipment that is indicated to have a factory-primed finish for field painting.

3.4 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
- B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Design Professional, and leave in an undamaged condition.
- D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.5 INTERIOR PAINTING SCHEDULE

A. Concrete Substrates, Horizontal Surfaces.

1. Epoxy System:

- a. Prime Coat: Epoxy, matching topcoat.
- b. Topcoat: Epoxy, Gloss:

- 1) S-W Armorseal 8100 Water Based Epoxy Floor Coating, B70 Series, at 2.0 to 4.0 mils dry, per coat.

B. CMU Substrates:

1. Latex System: MPI INT 4.2A.

- a. Prime Coat: Interior/exterior latex block filler.
- b. Intermediate Coat: Interior latex matching topcoat.

- c. Topcoat: Interior latex semigloss.
- C. Steel Substrates:
 - 1. Alkyd System: MPI INT 5.1E.
 - a. Prime Coat: Quick-drying alkyd metal primer.
 - b. Intermediate Coat: Interior alkyd matching topcoat.
 - c. Topcoat: Interior alkyd semigloss.
- D. Galvanized-Metal Substrates:
 - 1. Alkyd System: MPI INT 5.3C.
 - a. Prime Coat: Cementitious galvanized-metal primer.
 - b. Intermediate Coat: Interior alkyd matching topcoat.
 - c. Topcoat: Interior alkyd semigloss.
- E. Aluminum (Not Anodized or Otherwise Coated) Substrates:
 - 1. Alkyd Over Quick-Drying Primer System: MPI INT 5.4J.
 - a. Prime Coat: Quick-drying primer for aluminum.
 - b. Intermediate Coat: Interior alkyd matching topcoat.
 - c. Topcoat: Interior alkyd semigloss gloss.
- F. Gypsum Board Substrates:
 - 1. Latex System: MPI INT 9.2A.
 - a. Prime Coat: Interior latex primer/sealer matching topcoat.
 - b. Intermediate Coat: Interior latex matching topcoat.
 - c. Topcoat: Interior latex eggshell.

END OF SECTION 099123

SECTION 099600

HIGH PERFORMANCE COATINGS

PART 1 - GENERAL

1.01 SCOPE:

- A. The work of this section consists of furnishing all materials, labor, equipment and incidentals required and performing all the painting necessary to complete this Contract in its entirety.
- B. It is the intent of these Specifications to paint all exposed concrete, masonry, miscellaneous metal, pipe, fittings, supports, valves, equipment, pre-engineered metal buildings and all other work obviously required to be painted except as otherwise specified. Minor items omitted in the schedule of work shall be included in the work of this Section where they come within the general intent of the specifications as stated herein.
- C. The following surfaces or items are not required to be painted:
 - 1. Portions of metal, other than aluminum, embedded in concrete. This does not apply to the back face of items mounted to concrete or masonry surfaces which shall be painted before erection. Aluminum to be embedded in or in contact with concrete or masonry shall be coated to prevent electrolysis.
 - 2. Stainless steel.
 - 3. Finish hardware and door closures.
 - 4. Manhole frames and covers.
 - 5. Fiberglass other than piping and doors.
 - 6. Packing glands and other adjustable parts and nameplates of mechanical equipment.

1.02 REFERENCES:

- A. Steel Structures Painting Council (SSPC)
- B. American Association of State Highway and Transportation Officials (AASHTO).
- C. Occupational Safety and Health Act (OSHA).

1.03 SUBMITTALS:

- A. Submit to the Engineer for review in accordance with Section 01500, or drawings, working drawings, and product data including manufacturer's specifications and data on the proposed paint systems and detailed surface preparation, application procedures and dry film thickness.
- B. Submit to the Engineer for review in accordance with Section 01500, color cards, including standard and special colors, for initial color selections. The Owner will select all final paint colors to be used on this project.
- C. Schedule of Painting Operations: Submit to the Engineer for review a complete Schedule of Painting Operations within 90 days after the Notice to Proceed. This schedule is imperative so that the various fabricators may be notified of the proper shop prime coat to apply. Properly notify and coordinate the fabricators' surface preparation and painting operations with these Specifications. This Schedule shall include for each surface to be painted, the brand name, the percent volume of solids, the coverage and the number of coats the Contractor proposes to use in order to achieve the specified dry film thickness, and color charts. When the Schedule has been approved, apply all material in strict accordance with the approved Schedule and the manufacturer's instructions. Wet and dry paint film gauges shall be made available to the Engineer to verify the proper application while work is in progress.

1.04 PRE-PAINTING CONFERENCE:

- A. Well in advance of commencement of painting operations, but after major equipment has been delivered, a pre-painting conference shall be held. All parties with an interest in the painting work shall attend including the Contractor, the Manufacturer, the Owner, the Engineer, and the painting subcontractor and his foreman. The Contractor shall contact each party and arrange the meeting.
- B. The conference shall include an inspection of the areas to be painted by all parties and discussion of the conformance of each area with the specifications. Important issues such as environmental conditions climate control systems, original primer dry film thickness, and monitoring the number of coats that have been field applied shall be discussed and problems shall be resolved.
- C. A written record of the meeting shall be submitted to the Engineer.

1.05 PAINT STORAGE SAFETY PRECAUTIONS:

- A. The area selected for paint storage and mixing must have good natural or mechanical ventilation. It shall be posted as a "no smoking area" and this regulation strictly enforced.
- B. Paints, turpentines, spirits, thinners and all other inflammable liquids shall be kept in closed metal containers. Brushes and rollers left in solvent or brush cleaner must be kept in closed containers.
- C. There shall be no open containers of any inflammable liquids including paint left in the storage or mixing area. Waste, rags, paper and similar combustible material shall be placed in metal containers provided with self-closing covers. These containers are to be emptied regularly and the contents removed from the premises.
- D. Where paint is applied in confined or enclosed areas proper ventilation and equipment shall be provided for worker's safety.
- E. All paints shall be properly prepared by the manufacturer and delivered to the site for field painting in the original unbroken containers with manufacturer's label plainly printed thereon. Each container shall provide labels with following information: Name or title of material; manufacturers name; contents by volume for major pigment and vehicle constituents; date of manufacture; thinning instructions; and application instructions.
- F. Type of material to be applied at each location shall be submitted to the Engineer with the manufacturer's written recommendation of the type paint for each item to be painted.
- G. Containers which are broken, opened, water-marked and/or contain caked, lumpy, or otherwise damaged materials, are unacceptable and shall immediately be removed from the work site.
- H. The Contractor shall exercise every precaution in the storing of paints, solvents, cleaning fluids, rags, and similar materials as to eliminate the risk of spontaneous combustion or other hazardous conditions. Portable fire extinguishing equipment shall be provided in a convenient location for emergency access. All painting materials stored on the job site shall be stored in a location outside of the work area. The Contractor shall take all safety precautions in accordance with Section 7 of AWWA D-102, NFPA Bulletin No. 101 and all federal, state and local regulations.

PART 2 - PRODUCTS

2.01 MATERIALS:

- A. Materials shall be delivered at the site in the original containers bearing manufacturer's labels, with labels intact and seals unbroken. All mixing and tinting shall be done on the premises and no materials shall be reduced or changed, except as specified by the manufacturer of the material.
- B. No materials shall be delivered at the site, except such as have been approved by the Engineer as to manufacture, brand and quality.
- C. Each paint and finish shall be the manufacturer's best grade of the kind called for, and each shall be suitable for the use required and over the primer used.
- D. The full names of manufacturers that are designated by abbreviations in the Systems Schedule are as follows:
 - 1. Tnemec
 - 2. Raven
 - 3. Induron
 - 4. Sherwin Williams
 - 5. Approved equal.
- E. See also the General and/or Special Conditions on substitutions and "or equals."
- F. All paint which may come in contact with the water being treated shall be U.S. Environmental Protection Agency (EPA) approved for use with potable water. Contractor shall furnish three (3) copies of an affidavit from manufacturers that the paint materials are approved by the U.S. EPA for contact with potable water.

2.02 COLOR AND FINISHES:

Except as otherwise specified, colors shall be selected by the Owner. Submit samples as directed for selection and approval. The finished work shall be in accordance with approved samples in each case. Samples of finish shall be about 6 inches x 18 inches and shall be on materials similar to those to be finished in each case. See article hereinafter on piping, etc.

2.03 PAINTING AND FINISHING SCHEDULE:

A. Painting Schedule:

*Follow painting schedule unless the drawings indicate otherwise.

<u>SURFACE</u>	<u>PAINT SYSTEM</u>
Concrete walls & ceilings as indicated on the drawings.	A
Concrete block walls not otherwise shown or specified.	B
Miscellaneous metal, ferrous, interior.	C
Miscellaneous metal, ferrous, exterior.	D
Wood trim	F
Door frames and misc. metals.	G
Hollow metal doors, frames and panels.	H
Gypsum board walls	I
Gypsum board ceilings	J
Process equipment & piping, all ferrous parts located below fluid level or subject to splash.	K
Electric panelboards.	K
Process equipment & piping, all ferrous parts, including bridges, etc., above fluid level & not subject to splash.	L
Previously painted process equipment & piping, all ferrous parts located below the fluid level or subject to splash.	M
Previously painted process equipment & piping, all ferrous parts located above the fluid level & not subject to splash.	N
Stainless steel and aluminum.	No Paint
Process & other piping not insulated.	P
Insulated piping & ducts.	Q

<u>SURFACE (CONTINUED)</u>	<u>PAINT SYSTEM</u>
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Exterior concrete surfaces (above grade).	X
Exterior masonry surfaces.	X
Interior concrete floors & stairs.	No Paint
Aluminum doors.	No Paint
Conduit, aluminum	No paint, except may be painted same as walls & ceilings where surface mounted
Conduit, PVC	P

B. Finishing Schedule

1. SYSTEM A: 2 Coats T-Series 180 or I-AC 230 applied at a minimum dry film thickness of 4.0 - 8.0 mils per coat. Total dry film thickness 8.0 - 16.0 mils.
2. SYSTEM B: 1 Coat T-54-562 Masonry Filler or I-AC 220 Acrylic Block Filler applied at a square foot coverage of 60 to 80 sq. ft per gallon and 1 Coat T-Series 113 or I-AC 303 Acrylic Epoxy applied at a minimum dry film thickness of 4.0 - 8.0 mils. Total dry film thickness (excluding filler) not less than 4.0 mils.
3. SYSTEM C: Touch-up Shop Coat T-Series 135 or I-Induramastic-85, plus: 2 Coats T-Series 113 or I-AC 303 Acrylic Epoxy applied at a minimum dry film thickness of 4.0 - 8.0 mils per coat. Total dry film thickness 8.0 - 16.0 mils.
4. SYSTEM D: Touch-up Shop Coat T-Series 135 or I-Induramastic-85, plus: 1 Coat T-Series 66 Hi-Build Epoxoline or I-Armorguard Epoxy applied at a minimum dry film thickness of 3.0 - 5.0 mils. 1 Coat T-Series 73 or I-Indurethane 5500 applied at a minimum dry film thickness of 2.0 - 3.0 mils. Total dry film thickness 5.0 - 8.0 mils.
5. SYSTEM F: 1 Coat T Series 36-603 Undercoater or I-AC 301 Wood Primer or P-Series 17-21 applied at minimum dry film thickness 2.0 – 3.0 mils and 2 Coat T Series 2H Tneme-Gloss or I-Armorlux 2500 or P-Series 95 applied at a minimum dry film thickness of 1.5 – 2.0 mils per coat. Total dry film thickness 5.0 – 7.0 mils.
6. SYSTEM G: Touch-up Shop Coat T-Series 135 or I-Induramastic-85, plus: 2 Coats T-Series 66 Hi-Build Epoxoline or I-Armorguard Epoxy applied at a minimum dry film thickness of 2.0 - 3.0 mils per coat. Total dry film thickness

4.0 - 6.0 mils. If exterior exposed, 1 Coat T-Series 73 or I-Indurethane 5500 applied at a minimum dry film thickness of 2.0 - 3.0 mils. Total dry film thickness 6.0 - 9.0 mils.

7. SYSTEM H: Touch-up Shop Prime Coat, plus: 2 Coats T-Series 2H Gloss or I-Armorlux 2500 applied at a minimum dry film thickness of 1.5 - 2.0 mils per coat. Total dry film thickness 3.0 - 4.0 mils.
8. SYSTEM I: 1 Coat T-Series 51-792 PVA Sealer or I-AC 210 Masonry Sealer applied at a minimum dry film thickness of 1.0 - 2.0 mils and 2 Coats T-Series 6 Tnemec-Cryl or I-AC 230 Acrylic Eggshell applied at a minimum dry film thickness of 2.0 - 3.0 mils per coat. Total dry film thickness 5.0 - 8.0 mils.
9. SYSTEM J: 1 Coat T-Series 51-792 PVA Sealer or I-AC 210 Masonry Sealer applied at a minimum dry film thickness of 1.0 - 2.0 mils and 2 Coats T-Series 6 Tnemec-Cryl or I-AC 230 Acrylic Eggshell applied at a minimum dry film thickness of 2.0 - 3.0 mils per coat. Total dry film thickness 5.0 - 8.0 mils.
10. SYSTEM K: Surface preparation as required by coating manufacturer except not less than Commercial Blast (SSPC-SP6) for Non-Immersion service and Near-White Blast (SPCC-SP10) for Immersion service. Primer is to be shop applied by equipment manufacturer except where noted, but must be compatible with finish coats to be applied under this section, and shall be:

1 Coat T-Series 66 Hi-Build Epoxoline or I-PE-54 Epoxy Primer applied at a minimum dry film thickness of 3.0 - 5.0 mils.

After erection apply:

1 Coat T-Series 66 Hi-Build Epoxoline or I-Armorguard Epoxy applied at a minimum dry film thickness of 4.0 - 6.0 mils. Total dry film thickness 7.0 - 11.0 mils.

11. SYSTEM L: Surface preparation as required by coating manufacturer except not less than Commercial Blast (SSPC-SP6) for Non-Immersion service and Near-White Blast (SPCC-SP10) for Immersion service. Primer is to be shop applied by equipment manufacturer except where noted, but must be compatible with finish coats to be applied under this section, and shall be:

1 Coat T-Series 66 Hi-Build Epoxoline or I-PE-54 Epoxy Primer applied at a minimum dry film thickness of 3.0 - 5.0 mils.

After erection apply:

1 Coat T-Series 66 Hi-Build Epoxoline or I-Armorguard Epoxy applied at a minimum dry film thickness of 4.0 - 6.0 mils. Total dry film thickness 7.0 - 11.0 mils.

12. SYSTEM M: Surface preparation as required by coating manufacturer except not less than Commercial Blast (SSPC-SP6) for Non-Immersion service and Near-White Blast (SPCC-SP10) for Immersion service. Primer is to be shop applied by equipment manufacturer except where noted, but must be compatible with finish coats to be applied under this section, and shall be:

1 Coat T-Series 66 Hi-Build Epoxoline or I-PE-54 Epoxy Primer applied at a minimum dry film thickness of 3.0 - 5.0 mils.

After erection apply:

1 Coat T-Series 66 Hi-Build Epoxoline or I-Armorguard Epoxy applied at a minimum dry film thickness of 4.0 - 6.0 mils. Total dry film thickness 7.0 - 11.0 mils.

13. SYSTEM N: Surface preparation as required by coating manufacturer except not less than Commercial Blast (SSPC-SP6) for Non-Immersion service and Near-White Blast (SPCC-SP10) for Immersion service. Primer is to be shop applied by equipment manufacturer except where noted, but must be compatible with finish coats to be applied under this section, and shall be:

1 Coat T-Series 66 Hi-Build Epoxoline or I-PE-54 Epoxy Primer applied at a minimum dry film thickness of 3.0 - 5.0 mils.

After erection apply:

1 Coat T-Series 66 Hi-Build Epoxoline or I-Armorguard Epoxy applied at a minimum dry film thickness of 4.0 - 6.0 mils. Total dry film thickness 7.0 - 11.0 mils.

14. SYSTEM O: Stenciling and signs, only, as specified elsewhere in this section.

15. SYSTEM P: 2 Coats T-Series 66 Hi-Build Epoxoline or I-Armorguard Epoxy applies at a minimum dry film thickness of 3.0 - 5.0 mils (1st Coat) and 4.0 - 6.0 mils (2nd Coat). Also color coding and stenciling and signs as specified elsewhere in this section. Total dry film thickness 7.0 - 11.0 mils.

Process piping colors shall be in accordance with the Water Environment Federation (WEF) Plant Piping Color Code.

16. SYSTEM Q: 2 Coats T-Series 6-Tnemec-Cryl or I-AC 230 Acrylic Eggshell applied at a minimum dry film thickness of 2.0 - 3.0 mils per coat. Also, if

process piping stenciling and signs as specified. Total dry film thickness 4.0 - 6.0 mils.

17. SYSTEM X: Existing concrete and masonry surfaces shall be wire brushed or "water-blasted" and otherwise prepared per the coating manufacturer's instructions. The surfaces shall be finished 2 Coats T-Series 156 EnviroCrete or I-AC 403 Elastomeric applied at a minimum dry film thickness of 4.0 - 6.0 mils per coat. First coat to be spray applied and back rolled. Total dry film thickness of 8.0 -12.0 mils. If surface has been previously painted, a tie-coat of T-Series 151 or I-AC 210 Masonry Sealer is required prior to applying T-Series 156 EnviroCrete or I-AC 403 Acrylic Elastomeric.

2.04 COLOR CODING FOR PIPES AND EQUIPMENT:

- A. When color coding is specified, it shall consist of color code painting and identification of all exposed conduits, trough items and pipelines for the transport of gases, liquid and semi-liquids including all accessories such as valves, insulated pipe coverings, fittings, junction boxes, bus bars, connectors and all operating accessories which are integral to be whole functional mechanical pipe and electrical conduit system. Colors shall be selected by the Owner.
- B. All hangers and pipe support floor stands shall be painted the same color and with the same paint as the pipe it supports. The system shall be painted up to but not including the flanges attached to the mechanical equipment nor the flexible conduit connected to electrical motors. When more than one pipe system is supported on the same bracket, the bracket shall be painted the same color as the adjacent wall or ceiling. Colors shall be selected by the Owner.
- C. All systems which are an integral part of the equipment, that is originating from the equipment and returning to the same piece of equipment, shall be painted between and up to but not including, the fixed flanges or connections on the equipment.
- D. The color code establishes, defines and assigns a definite color for each category of pipe. All colors are assigned by the Owner and shall be treated as an integral part of the Contract.
- E. Banding for pipes shall be as specified by the Owner. Bands shall be 2 inches wide and spaced at 2 feet on center.

2.05 LETTERING OF TITLES:

- A. Each pipe system shall be labeled with the name of the materials in each pipeline and alongside this an arrow indicating the direction of flow of liquids. Titles shall

be as so described in attached schedule. Titles shall not be located more than 20 linear feet apart and shall also appear directly adjacent to each side of any wall the pipeline breaches, adjacent to each side of the valve regulator, flowcheck, strainer cleanout, and all pieces of equipment.

- B. Titles shall identify the contents by complete name. Identification title locations shall be determined by the Engineer but in general they shall be placed where the view is unobstructed and on the two lower quarters of pipe or covering where they are overhead. Title should be clearly visible from operating positions especially those adjacent to control valves.
- C. Titles on equipment shall be applied at eye level on machines where possible or at the upper most broad vertical surface of low equipment. Where more than one piece of the equipment item to be titled exists, the items shall be numbered consecutively as indicated on the mechanical drawings or as directed by the Engineer; for example Pump No. 1, Pump No. 2, etc. Titles shall be composed and justified on the left hand side as follows:

Pump No. 1

- D. Application of titles.
 - 1. The color of the titles shall be black or white as approved, to best contrast with the color of the pipes and equipment and shall be stencil applied.
 - 2. Stencil text is to be in ALL CAPS worded exactly as shown in the Schedule. Titles are to be printed in a single line.
 - 3. Letter sizes.

Outside Diameter of Pipe or Covering (inches)	Size of Legend Letters (inches)
$\frac{3}{4}$ to $1\frac{1}{4}$	$\frac{1}{2}$
$1\frac{1}{2}$ to 2	$\frac{3}{4}$
$2\frac{1}{2}$ to 6	$1\frac{1}{4}$
8 to 10	$2\frac{1}{2}$
More than 10	$3\frac{1}{2}$
 - 4. Equipment titles are to be two inches high.
 - 5. Arrow sizes. Where "a" is equal to $\frac{3}{4}$ of outside diameter of pipe or covering, the arrow shaft shall be 2 "a" long by $\frac{3}{8}$ "a" wide. The arrow head shall be an equilateral triangle with sides equal to "a." Maximum "a" dimension shall be 6 inches.

6. When using direction arrows, point arrowhead away from pipe markers and indirection of flow. If flow can be in both directions, use a double-headed directional flow.

2.06 METAL TAGS:

For pipelines smaller than $\frac{3}{4}$ -inch in diameter, securely fasten metal tags, $2\frac{1}{2}$ inches x $\frac{1}{2}$ -inches, of 17 Birmingham Stubs Gage Brass with lettering etched and filled with enamel. Tags shall be approved by the Engineer.

2.07 FABRICATED EQUIPMENT:

- A. Unless otherwise indicated all fabricated equipment shall be shop primed and shop or field finished.
- B. All items to be shop primed shall be thoroughly cleaned of all loose material prior to priming. If, in the opinion of the Engineer, any prime coating shall have been improperly applied or if material contrary to these Specifications shall have been used, that coating shall be removed by sandblasting to white metal and reprimed in accordance with the Specifications.
- C. All shop prime coats shall be of the correct materials and applied in accordance with these Specifications. Remove any prime coats not in accordance with these Specifications by sandblasting and apply the specified prime coat at no additional cost to the Owner.
- D. Shop primed surfaces shall be cleaned thoroughly and damaged or bare spots retouched with the specified primer before the application of successive paint coats in the field.
- E. Be responsible for and take whatever steps are necessary to properly protect the shop prime and finish coats against damage from weather or any other cause.
- F. A shop finish coat shall be equal in appearance and protection quality to a field applied finish coat. If, in the opinion of the Engineer, a shop finish coat does not give the appearance and protection quality of other work of similar nature, prepare the surfaces and apply the coat or coats of paint as directed by the Engineer to accomplish the desired appearance and protection quality. Submit to the Engineer substantial evidence that the standard finish is compatible with the specified finish coat.
- G. Wherever fabricated equipment is required to be sandblasted, protect all motors, drives, bearings, gears, etc., from the entry of grit. Any equipment found to contain grit shall be promptly and thoroughly cleaned.

PART 3 - EXECUTION

3.01 PREPARATION OF SURFACES:

- A. The Contractor is wholly responsible for the finish of all work. All surfaces to be painted shall be prepared as specified herein and shall be dry and clean before painting. Special care shall be given to thoroughly clean interior concrete and concrete block surfaces of all marks before application of finish.
- B. All metal welds, blisters, etc., shall be ground and sanded smooth in accordance with SSPC-SP-3 or in difficult and otherwise inaccessible areas by hand cleaning in accordance with SSPC-SP-2. All pits and dents shall be filled and all imperfections shall be corrected so as to provide a smooth surface for painting. All rust, loose scale, oil, grease and dirt shall be removed by use of approved solvents, wire brushing or sanding.
- C. Concrete surfaces shall have been finished as specified in Division 3. Report unsatisfactory surfaces to the Engineer. Concrete shall be free of dust, oil, curing compounds, and other foreign matter.
- D. Concrete block surface shall be smooth and cleaned of all dust, efflorescence, chalk, loose mortar, dirt, grease, oil, tar and other foreign matter.
- E. All plastic pipe surfaces shall be lightly sanded before painting.
- F. Wood Surfaces shall be dry. Sand to obtain a smooth surface. All encrustations shall be removed.
- G. Exposed Pipe: Bituminous coated pipe shall not be used in exposed locations. Pipe which shall be exposed after project completion shall be primed in accordance with the requirements herein. Any bituminous coated pipe which is inadvertently installed in exposed locations shall be sandblasted clean before priming and painting. After installation all exterior, exposed flanged joints shall have the gap between adjoining flanges sealed with a single component polysulfide sealant to prevent rust stains.
- H. Primed or Previously Painted Surfaces and Nonferrous Surfaces: All coated surfaces shall be cleaned prior to application of successive coats. All nonferrous metals not to be coated shall be cleaned. This cleaning shall be done in accordance with SSPC-SP-1, Solvent Cleaning.
- I. Shop-Finished Surfaces: All shop-coated surfaces shall be protected from damage and corrosion before and after installation by treating damaged areas

immediately upon detection. Abraded or corroded spots on shop-coated surfaces shall be "Hand Cleaned" and then touched up with the same materials as the shop coat. All shop coated surfaces which are faded, discolored, or which require more than minor touch-up in the opinion of the Engineer shall receive new surface preparation before being repainted. Cut edges of galvanized sheets and exposed threads and cut ends of galvanized piping, electrical conduit, and metal pipe sleeves, that are not to be finished painted, shall be "Solvent Cleaned" and primed with zinc dust-zinc oxide metal primer.

- J. Galvanized and Zinc-Copper Alloy Surfaces: These surfaces to be painted shall be "Solvent Cleaned" and treated as hereinafter specified. Such surfaces not to be painted shall be "Solvent Cleaned."
- K. Aluminum embedded or in contact with concrete must be painted with one shop coat of zinc chromate followed by one heavy coat of aluminum pigmented asphalt paint.

3.02 WORKMANSHIP:

A. General:

1. Primer and paint used for a particular surface shall, in general, be as scheduled for that type of new surface. Confirm with the paint manufacturer that the paint proposed for a particular repaint condition will be compatible with existing painted surface. Sample repainted areas on the actual site will be required to insure this compatibility. Finished repainted areas shall be covered by the same guarantee specified for remainder of work.
2. At the request of the Engineer, samples of the finished work prepared in strict accordance with these Specifications shall be furnished and all painting shall be equal in quality to the approved samples. Finished areas shall be adequate for the purpose of determining the quality of workmanship. Experimentation with color tints shall be furnished to the satisfaction of the Engineer where standard chart colors are not satisfactory.
3. Protection of furniture and other movable objects, equipment, fittings and accessories shall be provided throughout the painting operations. Canopies of lighting fixtures shall be loosened and removed from contact with surface, covered and protected and reset upon completion. Remove all electric plates, surface hardware, etc., before painting, protect and replace when completed. Mask all machinery name plates and all machined parts not receiving a paint finish. Dripped or spattered paint shall be promptly removed. Lay drop cloths in all areas where painting is

being done to adequately protect flooring and other work from all damage during the operation and until the finished job is accepted.

4. On metal surfaces apply each coat of paint at the rate specified by the manufacturer to achieve the minimum dry mil thickness required. If material has thickened or must be diluted for application by spray gun, the coating shall be built up to the same film thickness achieved with undiluted material. One gallon of paint as originally furnished by the manufacturer shall not cover a greater area when applied by spray gun than when applied unthinned by brush. Deficiencies in film thickness shall be corrected by the application of an additional coat(s). On masonry, application rates will vary according to surface texture, however, in no case shall the manufacturer's stated coverage rate be exceeded. On porous surfaces, it shall be the painter's responsibility to achieve a protective and decorative finish either by decreasing the coverage rate or by applying additional coats of paint.
5. Paints shall be mixed in proper containers of adequate capacity. All paints shall be thoroughly stirred before use and shall be kept stirred while using. No unauthorized thinners or other materials shall be added to any paint.
6. Only skilled painters shall be used on the work and specialists shall be employed where required.
7. Mixing, thinning, pot life, application procedure, equipment, coverage, curing, re-coating, storage and number of coats shall be in accordance with coating manufacturer's instructions.
8. Avoid degradation and contamination of blasted surfaces, and avoid between coat contamination. Surfaces contaminated shall be cleaned before applying next coat. Method of cleaning contaminated surface shall be approved by the Engineer or owner's representative.
9. Each application of material shall be worked into corners, crevices, joints, etc., and distributed evenly over flat surfaces. Spraying techniques that result in a uniform wet pattern shall be used and dry spraying should be avoided. Dry spray shall be removed prior to coating being applied.
10. All bolts, welds, sharp edges, and difficult access areas shall receive a primer brush coat or spray coat prior to primer spray application.

B. Field Priming:

1. Steel members, metal castings, mechanical and electrical equipment and other metals which are shop primed before delivery at the site will not

require a prime coat on the job. All piping and other bare metals to be painted shall receive one coat of primer before exposure to the weather, and this prime coat shall be the first coat as specified in the painting schedule.

2. Equipment which is customarily shipped with a baked-on enamel finish or with a standard factory finish shall normally be field painted unless the prefinished equipment is specifically color selected and unless the finish has not been damaged in transit or during installation. Surfaces that have been shop painted and have been damaged, or where the shop coats or coats of paint have deteriorated, shall be properly cleaned and retouched before any successive painting is done on them in the field. All such field painting shall match as nearly as possible the original finish

C. Field Painting:

1. All painting at the site shall be designated as Field Painting.
2. All paint shall be at room temperature before applying, and no painting shall be done when the temperature is below 50 degrees F, in dust-laden air, when rain or snow is falling, or until all traces of moisture have completely disappeared from the surface to be painted.
3. No paint shall be applied when the air or surface temperature, as measured in the shade, is below that which is recommended by the manufacturer. Paint shall not be applied to wet or damp surfaces, and shall not be applied in rain, snow, fog, mist, or when the surface temperature will be less than 5 F above the dew point. No paint shall be applied when it is expected that the surface temperature will drop below the manufacturer's recommendation within eight hours after the application of the paint. Dew or moisture condensation should be anticipated, and if such conditions are prevalent, painting shall be delayed until it is certain that the surfaces are dry; further, the days painting shall be completed well in advance of the probable time of day when moisture condensation will occur, in order to permit the film the required drying time as specified by the manufacturer prior to the formation of moisture. Care must be exercised that the coatings are not applied in too heavy a coat above that recommended by the manufacturer and that adequate drying time is permitted between coats to assure proper release of solvents.
4. Successive coats of paint shall be tinted so as to make each coat easily distinguishable from each other with the final undercoat tinted to the approximate shade of the finished coat.

5. Finish surfaces shall not show brush marks or other irregularities. Undercoats shall be thoroughly and uniformly sanded with No. 00 sandpaper or equal to remove defects and provide a smooth even surface. Top and bottom edges of doors shall be painted and all exterior trim shall be back-primed before installation.
6. Painting shall be continuous and shall be accomplished in an orderly manner so as to facilitate inspection. All exterior concrete and masonry paint shall be performed at one continuous manner structure by structure. Materials subject to weathering shall be prime coated as quickly as possible. Surfaces of exposed members that will be inaccessible after erection shall be cleaned and painted before erection.
7. All materials shall be brush painted unless spray painting is specifically approved by the Engineer. The Contractor shall be responsible for all damage caused by overspray or drifting.
8. All surfaces to be painted as well as the atmosphere in which painting is to be done shall be kept warm and dry by heating and ventilation, if necessary, until each coat of paint has hardened. Any defective paint shall be scraped off and repainted in accordance with the Engineer's directions.
9. Before final acceptance of the work, all damaged surfaces of paint shall be cleaned and repainted as directed by the Engineer.
10. Any pipe scheduled to be painted and having received a coating of a tar or asphalt-compound shall be painted with two coats of Rust-Oleum 9578 Coal Tar Epoxy, Induron Ruff Stuff 3300 or equal.

3.03 CLEANUP:

- A. The premises shall at all times be kept free from accumulation of waste material and rubbish caused by employees or work. At the completion of the painting remove all tools, scaffolding, surplus materials, and all rubbish from and about the buildings and leave work "broom clean" unless more exactly specified.
- B. Upon completion, remove all paint where it has been spilled, splashed or splattered on all surfaces, including floors, fixtures, equipment, furniture, etc., leaving the work ready for inspection.
- C. All cloths and waste that might constitute a fire hazard shall be placed in closed metal containers or destroyed at the end of each day. Upon completion of the work, all staging, scaffolding, and containers shall be removed from the site and/or destroyed in an approved and legal manner. Paint spots, oil, or stains upon

adjacent surfaces and floors shall be completely removed , and the entire job left clean and acceptable to the Engineer.

3.04 PAINT:

A. General Notes and Guidelines:

1. Pipe lines, equipment and all other items shall be assigned a color by the Owner and shall be treated an integral part of the Contract.
2. All moving parts, drive assemblies, and covers for moving parts which are potential hazards shall be Safety Orange.
3. All safety equipment shall be painted in accordance with Occupation Safety and Health Act (OSHA) standards.
4. All inline equipment and appurtenances not assigned another color shall be painted the same base color as the piping. The pipe system shall be painted with the pipe color up to but not including the flanges attached to pumps and mechanical equipment assigned another color. Tanks shall be painted the color of the piping system that they serve, unless the tank is fiberglass.
5. Building surface colors shall be painted as selected by the Owner.
 - a. All color numbers and names herein refer to master color card.
 - b. Pipe lines, equipment or other items which are not listed here shall be assigned a color by the Engineer and shall be treated an integral part of the Contract.
 - c. All moving parts, drive assemblies, and covers for moving parts which are potential hazards shall be Safety Orange.
 - d. All safety equipment shall be painted in accordance with Occupation Safety and Health Act (OSHA) standards.
6. All inline equipment and appurtenances not assigned another color shall be painted the same base color as the piping. The pipe system shall be painted with the pipe color up to but not including the flanges attached to pumps and mechanical equipment assigned another color. Tanks shall be painted the color of the piping system that they serve, unless the tank is fiberglass.
7. Building surface colors shall be painted as scheduled in the Finish Schedule or as selected by the Engineer.
8. Colors of the finish schedule shall be as follows: (colors are based on Glidden color charts)

B. DAMAGED COATINGS:

1. Damaged coatings, pinholes, and holidays shall have edges feathered and repaired in accordance with the recommendations of the manufacturer, as approved by the Engineer.
2. All finish coats, including touch up and damage-repair coats shall be applied in a manner which will present a uniform texture and color-match appearance.

C. UNSATISFACTORY APPLICATION:

1. If the item has an improper finish, color, or insufficient film thickness, the surface shall be cleaned and topcoated with the specified material to obtain the specified color and coverage. Specific surface preparation information to be secured from the coatings manufacturer and the Engineer.
2. All visible areas of chipped, peeled, or abraded paint shall be hand or power-sanded, feathering the edges. The areas shall then be primed and finish coated in accordance with the specifications.
3. Work shall be free of runs, bridges, shiners, laps, or other imperfections. Evidence of these conditions shall be cause for rejection.
4. Any defects in the coating system shall be repaired by the Contractor per written recommendations of the coating manufacturer.

D. GUARANTEE AND ANNIVERSARY INSPECTION:

1. All work shall be warranted for a period of one year from date of acceptance of the project.
2. The Owner will notify the Contractor at least 30 days prior to the anniversary date and shall establish a date for the inspection. Any defects in the coating system shall be repaired by the Contractor at no additional cost to the Owner. Should a failure occur to 25% of the painted surface, either interior or exterior, the entire surface shall be cleaned and painted in accordance with these specifications.

END OF SECTION 099600

SECTION 09 97 23
PROTECTIVE COATING FOR CONCRETE AND MASONRY
SANITARY SEWER STRUCTURES

PART 1 – GENERAL

1.01 GENERAL

- A. This section specifies the requirements for protecting and/or rehabilitating the interior of concrete sanitary sewer structures by application of a protective coating to protect the concrete structure from hydrogen sulfide and acid generated by microbiological sources present in the municipal wastewater environment. Several acceptable alternate coatings are specified to allow competitive bids to be obtained. The protective coating shall also eliminate infiltration, repair voids, and enhance the structural integrity of the wetwell. Cementitious material will not be allowed for the protective coating, however, it will be allowed for patching operations.
- B. For lift station wetwells, coating limits shall be the wetwell walls and underside of top slab. Procedures for surface preparation, cleaning, application and testing are described herein.
- C. All receiving manholes and force main termination manholes shall be coated per this specification.

1.02 REFERENCES {These or the latest Standards shall be complied for this project}

- A. ASTM D638 - Tensile Properties of Plastics.
- B. ASTM D790 - Flexural Properties of Unreinforced and Reinforced Plastics.
- C. ASTM D695 - Compressive Properties of Rigid Plastics.
- D. ASTM D4414 - Standard Practice for Measurement of Wet Film Thickness of Organic Coatings by Notched Gauges
- E. ASTM D4541 - Pull-off Strength of Coatings Using a Portable Adhesion Tester.
- F. ASTM D2584 - Volatile Matter Content.
- G. ASTM D2240 - Durometer Hardness, Type D.

- H. ASTM D543 - Resistance of Plastics to Chemical Reagents.
- J. ASTM C109 - Compressive Strength Hydraulic Cement Mortars.
- K. ACI 506.2-77 - Specifications for Materials, Proportioning, and Application of Shotcrete.
- L. ASTM C478 - Bond Strength to Concrete: Concrete Failed.
- M. ASTM C496 - Tensile Strength of Chemically Setting Silicate and Silica Chemical Resistant Mortars.
- N. ASTM C579 - Compressive Strength of Chemically Setting Silicate and Silica Chemical Resistant Mortars.
- O. ASTM - The published standards of the American Society for Testing and Materials, West Conshohocken, PA.
- P. NACE - The published standards of National Association of Corrosion Engineers (NACE International), Houston, TX.
- Q. SSPC - The published standards of the Society of Protective Coatings, Pittsburgh, PA.
- R. ASTM C396 - Compressive Strength of Cement Mortars.
- S. ASTM C580 - Standard Test Method for Flexural Strength and Modulus of Elasticity of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing, and Polymer Concrete.
- T. ASTM D4541 - Standard Test Method for Drying Shrinkage of Mortar Containing Hydraulic Cement.
- U. ASTM D4787 - Standard Practice for Continuity Verification of Liquid or Sheet Depth Applied to Concrete Substrates.

1.03 SUBMITTALS

- A. Product Data:
 - 1. Technical data sheet on each product used, including ASTM test results indicating the product conforms to and is suitable for its intended use per these specifications.
 - 2. Material Safety Data Sheets (MSDS) for each product used.

3. Project specific guidelines and recommendations.
4. Reference documentation to confirm that the proposed coating system has a proven record of performance when used in the intended application, including a list of at least five (5) successful installations that have been in service for a period of at least three (3) years. The reference list shall include the name of the facility, the application date, a contact person, and a telephone number.
5. Warranty Certificate in accordance with Part 1.08 of this Section.
6. Applicator Qualifications
 - a. Manufacturer certification that Applicator has been trained and approved in the handling, mixing and application of the products to be used.
 - b. Certification that the equipment to be used for applying the products has been manufactured or approved by the concrete rehabilitation products manufacturer, protective coating manufacturer, and certified for proper use for this specific application.
 - c. Applicator must provide written documentation of having installed a minimum of 20,000 sq.ft. of protective coating similar to that specified within the last three (3) years.
 - d. Any project specific guidelines for the project.
 - e. Design details for any additional ancillary systems and equipment to be used in site and surfaced preparation, application and testing.

1.04 QUALITY ASSURANCE

- A. Applicator shall initiate and enforce quality control procedures consistent with applicable ASTM, NACE and SSPC standards and the protective coating manufacturer's recommendations.
- B. Coating Manufacturer's authorized field representative shall be on site prior to the application of the coating system to verify that the substrate has been properly prepared, and during the application of the coating system to certify that the coating system has been properly applied. The authorized field representative will provide the Owner with an accurate and objective written report stating inspection observations on the preparation, application, and final inspection

verifying adherence to coating manufacturer recommendations, industry standards, and the written specifications.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. All materials are to be kept dry, protected from weather and stored under cover.
- B. Protective coating materials are to be stored according to manufacturer's recommendations. Do not store near flame, heat or strong oxidants.
- C. Repair and protective coating materials are to be handled according to their material safety data sheets.

1.06 SITE CONDITIONS

- A. Applicator shall conform with all local, state and federal regulations including those set forth by OSHA, RCRA and the EPA and any other applicable authorities.
- B. Method statements and design procedures are to be provided by the Contractor when confined space entry is required.
- C. During coating operations, Contractor shall provide temporary bypassing of the lift station.

1.07 ACCESS TO THE WORK SITE

- A. Contractor shall provide proper facilities for access and observation of the Work and also for any inspection or testing by others.
- B. Contractor shall provide access to site inspection.

1.08 WARRANTY

- A. Manufacturer shall warrant all work against defects in materials and workmanship for a minimum period of five (5) years, unless otherwise noted, from the date of final acceptance of the project. Manufacturer shall, within a reasonable time after receipt of written notice thereof, repair defects in materials or workmanship if any develop during said five (5) year period, and any damage to other work caused by such defects or the repairing of same, at his own expense and without cost to the Owner. No prorated warranties or exclusions for improper application will be accepted for this project. Manufacturer shall also be responsible for the costs associated with by-pass pumping to maintain continuous service if repairs are necessary during the warranty period.

PART 2 - PRODUCTS

2.01 GENERAL

Cementitious patching, repair, and structural restoration materials used shall be only those specified and pre-approved. Project specific submittals shall be provided including application, cure time and surface preparation procedures which permit optimum bond strength with protective coating.

2.02 STRUCTURAL RESTORATION & COATING PRODUCTS

- A. RAVEN LINING SYSTEMS, Inc. , Product 405
- B. SPECTRASHIELD™ LINER SYSTEMS
- C. TNEMEC PERMA SHIELD H₂S, Series 434
- D. APPROVED EQUAL

2.03 APPROVED REPAIR MATERIALS

- A. Repair materials shall be used to fill voids, structurally reinforce and/or rebuild substrate surfaces, etc. as determined necessary by the engineer and protective coating applicator. Quick blending, rapid setting, high early strength, fiber reinforced, non-shrink repair mortar that can be trowelled or pneumatically spray applied must be compatible with the specified protective coating and shall be applied in accordance with the manufacturer's recommendations.
- B. The following products are accepted and approved as compatible repair basecoat materials for protective topcoating for use within the specifications.
 - 1. Infiltration Control
All fast setting materials furnished shall be applied directly to active leaks under hydrostatic pressure from the exterior of the concrete in wetwell structures or control by dewatering methods. Materials shall consist of rapid setting cements and various accelerating agents. Material shall not contain chlorides, gypsum, or metallic particles. Should groundwater be encountered, Contractor shall be responsible for utilizing a dewatering system(s) to remove water from the excavations.
 - 2. Repair, patching, and structural restoration
All material furnished shall be designed to fill voids and to repair or reconstruct where no hydrostatic pressure exists. Material shall consist of rapid setting cements, NSG aggregates, and various accelerating agents. Material shall not contain chlorides, gypsum, or metallic particles.

All structural restoration materials shall be specifically designed for the rehabilitation of wastewater pump station wetwells and other related concrete structures. Materials shall contain poly fiber reinforcement, fused calcium aluminate, and chemical admixtures.

2.04 MATERIAL PROPERTIES

A. Raven Product 405

1. Structural Restoration Material

Repair materials shall be used to fill voids, structurally reinforce and/or rebuild surfaces, etc. as determined necessary by the engineer and protective coating applicator. Repair materials must be compatible with the specified epoxy coating and shall be applied in accordance with the manufacturer's recommendations.

The following products may be accepted and approved as compatible repair basecoat materials for epoxy topcoating for use within the specifications:

- a. 100% solids epoxy grout specifically formulated for epoxy topcoating compatibility. The epoxy grout manufacturer shall provide instructions for trowel or spray application and for epoxy topcoating procedures.
- b. Factory blended, rapid setting, high early strength, fiber reinforced, non-shrink repair mortar that can be trowelled or pneumatically spray applied may be approved if specifically formulated to be suitable for epoxy topcoating. Such repair mortars should not be used unless their manufacturer provides information as to its suitability for topcoating with an epoxy coating. Project specific submittals should be provided including application, cure time and surface preparation procedures which permit optimum bond strength with the epoxy coating.
- c. Shotcrete shall conform to all requirements of ACI-506.2-77 as published by the American Concrete Institute, Detroit, MI except as modified by these specifications. Shotcrete shall be composed of Portland Cement, aggregate and water so proportioned as to produce a concrete suitable for pneumatic application. Shotcrete ingredients shall be selected and proportioned in such a manner as will produce concrete which will be compatible for epoxy topcoating. Shotcrete shall have a minimum surface tensile strength of 300 psi. No coatings shall be applied prior to a full 28 day cure unless test patches of coatings exhibit acceptable bonding

characteristics and no outgassing as prescribed herein or the repair mortar manufacturer certifies acceptable topcoating parameters.

2. Protective Coating Material

Product type	Amine cured epoxy
Color	Light blue
Solids Content (vol %)	100
Mix Ratio	3:1
Compressive Strength	18,000 psi
Tensile Strength	7,600 psi
Tensile Ultimate Elongation	1.5 %
Hardness	88
Film Thickness- Maximum	200 mils DFT per coat

B. SpectraShield Liner System

1. Structural Restoration Material
SpectraShield Liner Ssystem

2. Protective Coating
Multi-component stress panel liner system as follows:

a. Liner

Moisture displacement barrier	Primer
Moisture barrier	Modified Polymer
Surfacer	Polyurethane/Polymeric blend foam
Final corrosion barrier	Modified polymer

b. Primer shall be 100 % solids

c. Modified polymer shall be sprayable, solvent free, two- component polymeric, moisture/chemical barrier specifically developed for the corrosive wastewater environment.

Tensile Strength, psi	> 1,500 psi
Elongation	>125 %
Tear Strength	350 psi
Hardness, Type D	55-65

d. Polyurethane rigid structure foam

Density, nominal, core	4-10 lbs/CF
Compressive strength	90-150 psi
Shear strength	225-250 psi

- e. Total thickness of multicomponent stress panel liner shall be a minimum of 500 mils.
- f. Color- pink

C. TNEMEC Perma Shield H₂S, Series 434

1. Structural Restoration Material

Repair materials shall be used to fill voids, structurally reinforce and/or rebuild surfaces, etc. as determined necessary by the engineer and protective coating applicator. Repair materials must be compatible with the Perma Shield coating and shall be applied in accordance with the manufacturer's recommendations. Tnemec MortarClad, Series 218 or Tnemec Mortar Cast, Series 219 may be used.

2. Protective Coating

- a. An aggregate reinforced, 100 % solids, hybrid epoxy mortar (modified aliphatic amine epoxy mortar) designed for wastewater immersion/ fume environment.
- b. Primer-Concrete-Self priming or Tnemec Series 201 Epoxoprime Perma-Shield H₂S, Series 434- A thick fil, three part hybrid epoxy polymer designed to reduce permeability and withstand harsh wastewater environments.
- c. Film Thickness- 125 mils DFT minimum
- d. Topcoats-Perma-GlazeSeries 435, when specified, for improved aesthetics and additional protection against abrasion and chemical degradation .

2.05 STRUCTURAL RESTORATION MATERIAL AND PROTECTIVE COATING APPLICATION EQUIPMENT

Structural restoration mortars and protective coatings shall be applied with manufacturer approved equipment.

PART 3 - EXECUTION

3.01 ACCEPTABLE APPLICATORS

- A. Repair mortar must be applied by manufacturer trained and approved applicators. The repair mortar shall be applied according to manufacturer's recommendations.
- B. Protective coating must be applied by a Certified Applicator of the protective coating manufacturer and according to manufacturer's specifications.
- C. Appropriate flow control or flow diversion measures shall be taken.

3.02 EXAMINATION

- A. Appropriate actions shall be taken to comply with local, state and federal regulatory and other applicable agencies with regard to environment, health and safety.
- B. All bidders are required to verify that they have visited the jobsite, and are familiar with the conditions and the entire scope of work. Bidders shall field verify the attached plans and perform their own quantity measurements prior to bidding.
- C. Contractor shall provide a minimum 24 hour notice to the Inspector / Engineer for the following conditions:
 - 1. After final surface preparation is completed but before structure rehabilitation;
 - 2. After patching operations have cured, and
 - 3. After each coating layer is applied.
- D. Installation of the protective coating shall not commence until the concrete substrate has properly cured in accordance with these specifications.
- E. Temperature of the surface to be coated should be maintained between 60° F and 100° F during application. Prior to and during application, care should be taken to avoid exposure of direct sunlight or other intense heat source to the structure being coated. Where varying surface temperatures do exist, care should be taken to apply the coating when the temperature is falling versus rising (i.e., late afternoon into evening vs. morning into afternoon).

3.03 SURFACE PREPARATION

- A. Applicator shall inspect all surfaces specified to receive a protective coating prior to surface preparation. The existing piping, valves, and appurtenances shall be protected during structural rehabilitation and protective coating application.
- B. All contaminants including: oils, grease, incompatible existing coatings, waxes, form release, curing compounds, efflorescence, sealers, salts, or other contaminants shall be removed.
- C. All concrete or mortar that is not sound or has been damaged by chemical exposure shall be removed to a sound concrete surface or replaced.
- D. Old concrete must be firm and structurally sound as specified by the Engineer.
- E. Surface preparation method(s) should be based upon the conditions of the substrate, service environment and the requirements of the protective coating to be applied.
- F. Surfaces to receive protective coating shall be cleaned and abraded to produce a sound surface with adequate profile and porosity to provide a strong bond between the protective coating and the substrate. At a minimum, this will be achieved with a low pressure water cleaning equipment using a 0 degree rotating nozzle at a minimum 3,500 psi and 4 gpm. Other methods such as high pressure water jetting (refer to NACE Standard No. 6 /SSPC-SP 13), abrasive blasting, shotblasting, grinding, scarifying and/or acid etching may also be used. In addition, detergent water cleaning and hot water blasting may be necessary to remove oils, grease or other hydrocarbon residues from the concrete. The method(s) used shall be performed in a manner that provides a uniform, sound clean, neutralized surface that is not excessively damaged.

3.04 APPLICATION OF REPAIR MATERIALS

- A. Areas where structural steel has been exposed or removed shall be repaired in accordance with the Project Engineer's recommendations.
- B. Repair/Structural Restoration materials shall meet the specifications here and as described in part 2.03 and 2.04 of these specifications. The materials shall be applied utilizing proper equipment on to specified surfaces.
- C. Infiltration shall be stopped by using a material which is compatible with the specified repair mortar, waterproof quick setting mortar-type, that is suitable for topcoating with the specified protective coating. Contractor shall completely identify the types of grout, mortar, and sealant for repair of leak defects and provide case histories of successful use.
- D. Infiltration areas that require crack injection shall be covered in this scope of work. Injection holes shall be drilled through the wetwell at 120 degree angles

from each other at the same plane of elevation. Rows shall be separated no more than three vertical feet, and the holes shall be staggered with the holes in the rows above and below. Provide additional injection holes near observed defects and pipe seals. A minimum of 6 injection holes shall be provided per defect.

Grout shall be injected through holes under pressure with a suitable probe. Injection pressure shall not cause damage to the wetwell structure or surrounding surface features. Grout shall be injected through the lowest holes first. Grouting from the ground surface will not be allowed. Provide additional injection holes if necessary to ensure grout travel, verified by field observation of grout at adjacent defects or holes. Patch injection holes using a waterproof quick setting mortar after cleaning with a drill.

- E. The approved repair materials shall provide a smooth surface with an average profile equivalent to coarse sandpaper to optimally receive the protective coating. No bugholes or honeycomb surfaces should remain after the final trowel procedure of the repair mortar.
- F. The repair materials shall be permitted to cure according to manufacturer recommendations. Curing compounds should not be used unless approved for compatibility with the specified protective coating.
- G. After required cleaning and repair is performed, all surfaces shall be inspected for remaining laitance prior to protective coating application. Any evidence of remaining contamination or laitance shall be removed by additional abrasive blast, shotblast or other approved method. If repair materials are used, refer to these specifications for surface preparation. Areas to be coated must also be prepared in accordance with these specifications after receiving a repair mortar and prior to application of the protective coating.

3.05 APPLICATION OF PROTECTIVE COATING

- A. Application procedures shall conform to the recommendations of the protective coating manufacturer, including material handling, mixing, environmental controls during application, safety, and spray equipment.
- B. The equipment shall be specifically designed to accurately ratio and apply the specified protective coating materials and shall be regularly maintained and in proper working order.
- C. The protective coating material must be applied by a Certified applicator of the protective coating manufacturer.
- D. Specified surfaces shall be coated by a moisture tolerant, solvent-free, protective coating properties as described in part 2.03B of these specifications. Application shall be to an average wet film thickness of 125 mils nominal dry film thickness.

- E. Application equipment approved by the coating manufacturer shall be used to apply each coat of the protective coating. .
- F. If necessary, subsequent topcoating or additional coats of the protective coating should occur as soon as the basecoat becomes tack free, ideally within 12 hours but no later than the recoat window for the specified products. Additional surface preparation procedures will be required if this recoat window is exceeded.

3.06 TESTING AND INSPECTION

- A. During application a wet film thickness gage meeting ASTM D4414 - Standard Practice for Measurement of Wet Film Thickness of Organic Coatings by Notched Gages, shall be used to ensure a monolithic coating and uniform thickness during application.
- B. After the protective coating has set hard to the touch it shall be inspected with high-voltage holiday detection equipment meeting ASTM D4787 – Standard Practice for Continuity Verification of Liquid or Sheet Depth Applied to Concrete Substrates. The spark tester shall be initially set at 100 volts per 1 mil (25 microns) of film thickness applied. All detected holidays shall be marked and repaired by abrading the coating surface with grit disk paper or other hand tooling method. After abrading and cleaning, additional protective coating material can be hand applied to the repair area. All touch-up/repair procedures, for areas that do not meet the specified thickness, shall follow the protective coating manufacturer's recommendations.

The NACE Certified Coatings Inspector must be present and monitor the holiday testing (and repairs, if necessary). The final inspection report is to include the holiday testing results.

- C. A final visual inspection shall be made by the Inspector and manufacturer's representative. Any deficiencies in the finished coating shall be marked and repaired according to the procedures set forth herein by Applicator.

END OF SECTION

SECTION 101423 – PANEL SIGNAGE

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. All primary and secondary directories, directionals, room identification, workstation ID's and signage for ADA and life safety code compliance.
- B. Related Sections:
 - 1. Division 1: Administrative, procedural and temporary work requirements.

1.2 REFERENCES

- A. Signs and their installation shall comply with applicable provisions of the latest edition of the following standards and with requirements of authorities having jurisdiction:
 - 1. ADAAG – Americans with Disabilities Act Accessibility Guidelines; US Architectural and Transportation Barriers Compliance Board.
 - 2. International Code Council/American National Standards Institute A117.1- Standard on Accessible and Usable Buildings Facilities.
 - 3. National Fire Protection Association 101 Life Safety Code.

1.3 SUBMITTALS

- A. Submittals for Review:
 - 1. Signage schedule in manufacturer's format for verification of text/copy.
 - 2. Approval drawings showing materials, construction detail, lay-out, copy, size and mounting methods.
 - 3. Engineering drawings for each sign type.
 - 4. Sample of two sign types for verification of materials, color, pattern, overall quality, and for adherence to drawings and requirements indicated.

1.4 QUALIFICATIONS

- A. Manufacturer specializing in manufacturing the products specified in this section with minimum five years experience. Obtain signs from one source and a single manufacturer.

1.5 WARRANTY

- A. Provide manufacturer's warranty against defects in materials and workmanship for minimum 5 years.

PART 2 PRODUCTS

2.1 MANUFACTURER

- A. Signage shall be Fusion 43 as manufactured by Takeform, 1.800.528.1398, www.takeform.net or Design Professional approved equal.
- B. Alternate Manufacturers:
 - 1. 2/90
 - 2. ASI
 - 3. Best

2.2 SIGN STANDARDS

- A. It is the intent of these specifications to establish a sign standard for the Owner including but not limited to primary and secondary directories, wall mounted and overhead directionals, flag mounted directionals, primary room identification, restrooms, conference room, work station ID's and all code compliant signage. While the Owner may not obtain all signs and sign types, the signage contractor shall design and submit approval drawings for all.
- B. Typography:
 - 1. Type style: Copy shall be a true, clean, accurate reproduction of typeface(s) specified. Upper and lower case or all caps shall be as indicated in Sign Type drawings and Signage Schedule. Letter spacing to be normal and interline spacing shall be set by manufacturer.
 - 2. Arrows, symbols and logo art: To be provided in style, sizes, colors and spacing as shown in drawings.
 - 3. Grade II Braille utilizing perfectly round, clear insertion beads.
- C. Color and Finishes:
 - 1. Colors, patterns and artwork: As selected by Design Professional from Manufacturer's full range.
 - 2. Message Background: To be determined by Design Professional.
 - 3. Finishes are to meet current federal ADA and all state and local requirements.

2.3 SIGNS

- A. Signage System:
 - 1. The signage shall incorporate a decorative laminate face with applied graphics including all tactile requirements in adherence to ADA specifications.
 - 2. All signs, including work station and room ID's, overheads and flag mounts, directionals and directories shall have a matching appearance and constructed utilizing the same manufacturing process to assure a consistent look throughout.
- B. Materials:
 - 1. Sign face shall be 0.035" (nominal) standard grade, high pressure surface laminate. A painted sign face shall not be acceptable.

2. The sign shall incorporate balanced construction with the core sandwiched between laminates to prevent warping. Laminate on the sign face only shall not be acceptable.
 3. Tactile lettering shall be precision machined, raised 1/32", matte PETG and subsurface colored for scratch resistance.
 4. Signs shall incorporate a metal accent bar. Bars shall be anodized with a brushed satin finish. Painted bars shall not be acceptable. Refer to drawings.
- C. Standard Colors:
1. Face/background color shall be standard grade, high pressure laminate, all colors and finishes. Refer to drawings.
 2. Standard tactile colors shall match manufacturer's ADA standard color selection. Refer to drawings.
- D. Construction:
1. The signage shall, with the exception of directories and directionals, be a uniform 8 1/2" width to facilitate inserts printed on standard width paper.
 2. Insert components shall have a .080 thickness non-glare acrylic window and shall be inlaid flush to sign face for a smooth, seamless appearance.
 3. The signage shall include modules allowing for inserts, notice holders, occupancy sliders, marker, magnetic, and cork boards. All modules shall be flush to sign face for a smooth, seamless appearance.
 4. The laminates (front and back) shall be pressure laminated and precision machined together to a 90-degree angle. Edges shall be smooth, void of chips, burrs, sharp edges and marks.
 5. The signage shall utilize an acrylic sphere for Grade II Braille inserted directly into a scratch resistant, high pressure laminate sign face. Braille dots are to be pressure fit in high tolerance drilled holes.
 6. Braille dots shall be half hemispherical domed and protruding a minimum 0.025".
 7. The signage shall utilize a pressure activated adhesive. The adhesive shall be nonhazardous and shall allow for flexing and deflection of the adhered components due to changes in temperature and moisture without bond failure.
 8. All signs shall be provided with appropriate mounting hardware. Hardware shall be finished and architectural in appearance and suitable for the mounting surface.
 9. Some signs may be installed on glass. A blank backer is required to be placed on the opposite side of the glass to cover tape and adhesive. The backer shall match the sign in size and shape.
- E. Printed Inserts:
1. The signage shall be capable of accepting paper or acetate inserts to allow changing and updating as required. Insert components shall have a 0.080" thickness non-glare acrylic window and shall be inlaid flush to sign face for a smooth, seamless appearance.
 2. The signage contractor shall provide and install all signage inserts.
 3. Manufacturer shall provide a template containing layout, font, color, artwork and trim lines to allow Owner to produce inserts on laser or ink jet printer. The template shall be in an Acrobat or Word format (.pdf).

PART 3 EXECUTION

3.1 SITE VISITS

- A. Site visits – 3 site visits shall be required by the sign contractor:
 - 1. Prior to submission of bid for site assessment and evaluation.
 - 2. Post award for the purposes of meeting with Owners and project manager.
 - 3. Final walk-through and punchlist.
- B. Programming – sign contractor shall perform all wayfinding & programming. Programming shall include location plan, message schedule, and/or plots, fire/evacuation maps and insert graphics. All programming materials shall be submitted for approval.

3.2 CODE COMPLIANCE

- A. It shall be the responsibility of the successful bidder to meet any and all local, state, and federal code requirements in fabricating and installing signs.

3.3 DELIVERY, STORAGE, PROTECTION

- A. Package to prevent damage or deterioration during shipment, handling, storage and installation. Products should remain in original packaging until removal is necessary. Store products in a dry, indoor location.

3.4 EXAMINATION

- A. Installer shall examine signs for defects, damage and compliance with specifications. Installation shall not proceed until unsatisfactory conditions are corrected.

3.5 INSTALLATION

- A. General: Installation locations shall be in accordance with ADA specifications. Locate signs where indicated using mounting methods in compliance with manufacturer's written instructions:
 - 1. The signage contractor shall coordinate installation schedules with the Owner and/or Design Professional.
 - 2. Installation shall be performed by manufacturer's personnel trained and certified in manufacturer's methods and procedures.
 - 3. The signage contractor shall submit a CAD generated location plan noting the location of all signage and cross referenced to message schedule or plots for Design Professional's approval.
 - 4. Installer to conduct a pre-installation survey prior to manufacturing to verify copy and sign location. Each location shall be noted using a low tack vinyl reproduction of actual sign. Full scale renderings of directories and directionals shall also be provided. Any location discrepancy or message issues shall be submitted to Design Professional for review.
 - 5. Signs shall be level, plumb, and at heights indicated with sign surfaces free from defects.
 - 6. Provide a sign at all interior rooms and at stairs and toilets.
 - 7. Upon completion of the work, signage contractor shall remove unused or discarded materials, containers and debris from site.

3.6 STANDARDS MANUAL

- A. Manufacturer shall provide a comprehensive Standards Manual in both a paper and PDF format. The manual shall include all graphic standards, sign type descriptions, renderings showing color, pattern and finish, engineering drawings, location plans, plots, artwork, insert templates, mounting detail, and reorder information.

END OF SECTION 101423

SECTION 102113 - TOILET COMPARTMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes solid-polymer units as follows:
 - 1. Toilet Enclosures: Overhead braced Floor anchored.
 - 2. Entrance Screens: Overhead braced Floor anchored.
 - 3. Urinal Screens: Wall hung.
- B. Related Sections include the following:
 - 1. Division 06 Section "Rough Carpentry" for blocking.
 - 2. Division 10 "Toilet, Bath, and Laundry Accessories" for toilet tissue dispensers, grab bars, purse shelves, and similar accessories.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Show locations of cutouts for compartment-mounted toilet accessories.
 - 2. Show locations of reinforcements for compartment-mounted grab bars.
- C. Samples for Initial Selection: For each type of unit indicated.
- D. Samples for Verification: Of each type of color and finish required for units, prepared on 6-inch-square Samples of same thickness and material indicated for Work.

1.4 QUALITY ASSURANCE

- A. Comply with requirements in CID-A-A-60003, "Partitions, Toilets, Complete."

1.5 PROJECT CONDITIONS

- A. Field Measurements: Verify actual locations of walls, columns, ceilings, and other construction contiguous with toilet compartments by field measurements before fabrication and indicate measurements on Shop Drawings.
 - 1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating toilet compartments without field measurements. Coordinate wall, floor, ceilings, and other contiguous construction to ensure that actual dimensions correspond to established dimensions.

PART 2 - PRODUCTS

2.1 SOLID-POLYMER UNITS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Accurate Partitions Corporation.
 - 2. Ampco.
 - 3. Bradley Corporation; Mills Partitions.
 - 4. Capitol Partitions, Inc.
 - 5. Comtec Industries.
 - 6. General Partitions Mfg. Corp.
 - 7. Global Steel Products Corp.
 - 8. Metpar Corp.
 - 9. Santana Products, Inc.
 - 10. Sanymetal; a Crane Plumbing Company.
 - 11. Weis-Robart Partitions, Inc.
- B. Door, Panel, and Pilaster Construction: Solid, high-density polyethylene (HDPE), panel material, not less than 1 inch thick, seamless, with eased edges, and with homogenous color and pattern throughout thickness of material.
 - 1. Color and Pattern: as selected by Design Professional from manufacturer's full range of colors and patterns.
- C. Pilaster Shoes and Sleeves (Caps): Manufacturer's standard design; stainless steel.
- D. Brackets (Fittings):
 - 1. Full-Height (Continuous) Type: Manufacturer's standard design; stainless steel.
- E. Heat-Sink Strip: Manufacturer's standard continuous, extruded-aluminum strip fastened to exposed bottom edges of solid-polymer components to prevent burning.
- F. Overhead Cross Bracing for Ceiling-Hung Units: As recommended by manufacturer and fabricated from solid polymer.

2.2 ACCESSORIES

- A. Hardware and Accessories: Manufacturer's standard design, heavy-duty operating hardware and accessories.
 - 1. Material: Stainless steel.
- B. Overhead Bracing: Manufacturer's standard continuous, extruded-aluminum head rail with antigrip profile and in manufacturer's standard finish.
- C. Support Posts for Urinal Screens: Manufacturer's standard aluminum post with floor shoe for anchoring to floor construction.
- D. Anchorages and Fasteners: Manufacturer's standard exposed fasteners of stainless steel or chrome-plated steel or brass, finished to match hardware, with theft-resistant-type heads. Provide sex-type bolts for through-bolt applications. For concealed anchors, use hot-dip galvanized or other rust-resistant, protective-coated steel.

2.3 FABRICATION

- A. Overhead-Braced Units: Provide manufacturer's standard corrosion-resistant supports, leveling mechanism, fasteners, and anchors at pilasters to suit floor conditions. Make provisions for setting and securing continuous head rail at top of each pilaster. Provide shoes at pilasters to conceal supports and leveling mechanism.
- B. Floor-Anchored Units: Provide manufacturer's standard corrosion-resistant anchoring assemblies complete with threaded rods, lock washers, and leveling adjustment nuts at pilasters for structural connection to floor. Provide shoes at pilasters to conceal anchorage.
- C. Doors: Unless otherwise indicated, provide 24-inch- wide in-swinging doors for standard toilet compartments and 36-inch- wide out-swinging doors with a minimum 32-inch- wide clear opening for compartments indicated to be accessible to people with disabilities.
 - 1. Hinges: Manufacturer's standard self-closing type that can be adjusted to hold doors open at any angle up to 90 degrees.
 - 2. Latch and Keeper: Manufacturer's standard surface-mounted latch unit designed for emergency access and with combination rubber-faced door strike and keeper. Provide units that comply with accessibility requirements of authorities having jurisdiction at compartments indicated to be accessible to people with disabilities.
 - 3. Coat Hook: Manufacturer's standard combination hook and rubber-tipped bumper, sized to prevent door from hitting compartment-mounted accessories.
 - 4. Door Bumper: Manufacturer's standard rubber-tipped bumper at out-swinging doors and entrance screen doors.
 - 5. Door Pull: Manufacturer's standard unit at out-swinging doors that complies with accessibility requirements of authorities having jurisdiction. Provide units on both sides of doors at compartments indicated to be accessible to people with disabilities.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: Comply with manufacturer's written installation instructions. Install units rigid, straight, level, and plumb. Secure units in position with manufacturer's recommended anchoring devices.
 - 1. Maximum Clearances:
 - a. Pilasters and Panels: 1/2 inch.
 - b. Panels and Walls: 1 inch.
- B. Overhead-Braced Units: Secure pilasters to floor and level, plumb, and tighten. Secure continuous head rail to each pilaster with not less than two fasteners. Hang doors to align tops of doors with tops of panels and adjust so tops of doors are parallel with overhead brace when doors are in closed position.
- C. Floor-Anchored Units: Set pilasters with anchors penetrating not less than 2 inches into structural floor, unless otherwise indicated in manufacturer's written instructions. Level, plumb, and tighten pilasters. Hang doors and adjust so tops of doors are level with tops of pilasters when doors are in closed position.
- D. Wall-Hung and Post-Supported Urinal Screens: Attach with anchoring devices to suit supporting structure. Set units level and plumb and to resist lateral impact.

3.2 ADJUSTING

- A. Hardware Adjustment: Adjust and lubricate hardware according to manufacturer's written instructions for proper operation. Set hinges on in-swinging doors to hold doors open approximately 30 degrees from closed position when unlatched. Set hinges on out-swinging doors and doors in entrance screens to return doors to fully closed position.

END OF SECTION 102113

SECTION 102800 - TOILET AND BATH ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Washroom accessories.
 - 2. Under lavatory guards.
 - 3. Custodial accessories.
 - 4. Shower room accessories.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include the following:
 - 1. Construction details and dimensions.
 - 2. Anchoring and mounting requirements, including requirements for cutouts in other work and substrate preparation.
 - 3. Material and finish descriptions.
 - 4. Features that will be included for Project.
 - 5. Manufacturer's warranty.
- B. Samples: Full size, for each accessory item to verify design, operation, and finish requirements.
 - 1. Approved full-size Samples will be returned and may be used in the Work.
- C. Product Schedule: Indicating types, quantities, sizes, and installation locations by room of each accessory required.
 - 1. Identify locations using room designations indicated on Drawings.
 - 2. Identify products using designations indicated on Drawings.
- D. Maintenance Data: For toilet and bath accessories to include in maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Source Limitations: For products listed together in the same articles in Part 2, provide products of same manufacturer unless otherwise approved by Design Professional.

1.5 COORDINATION

- A. Coordinate accessory locations with other work to prevent interference with clearances required for access by people with disabilities, and for proper installation, adjustment, operation, cleaning, and servicing of accessories.
- B. Deliver inserts and anchoring devices set into concrete or masonry as required to prevent delaying the Work.

1.6 WARRANTY

- A. Special Mirror Warranty: Manufacturer's standard form in which manufacturer agrees to replace mirrors that develop visible silver spoilage defects and that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: 15 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Stainless Steel: ASTM A 666, Type 304, 0.0312-inch minimum nominal thickness, unless otherwise indicated.
- B. Steel Sheet: ASTM A 1008/A 1008M, Designation CS (cold rolled, commercial steel), 0.0359-inch minimum nominal thickness.
- C. Galvanized Steel Sheet: ASTM A 653/A 653M, with G60 hot-dip zinc coating.
- D. Galvanized Steel Mounting Devices: ASTM A 153/A 153M, hot-dip galvanized after fabrication.
- E. Fasteners: Screws, bolts, and other devices of same material as accessory unit and tamper-and-theft resistant where exposed, and of galvanized steel where concealed.
- F. Chrome Plating: ASTM B 456, Service Condition Number SC 2 (moderate service).
- G. Mirrors: ASTM C 1503, Mirror Glazing Quality, clear-glass mirrors, nominal 6.0 mm thick.
- H. ABS Plastic: Acrylonitrile-butadiene-styrene resin formulation.

2.2 WASHROOM ACCESSORIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. A & J Washroom Accessories, Inc.
 - 2. American Specialties, Inc.

3. Bobrick Washroom Equipment, Inc.
4. Bradley Corporation.
5. General Accessory Manufacturing Co. (GAMCO).

B. Toilet Tissue (Roll) Dispenser:

1. Description: Double-roll dispenser.
2. Mounting: Surface mounted.
3. Operation: Noncontrol delivery with standard spindle.
4. Capacity: Designed for 4-1/2- or 5-inch-diameter tissue rolls.
5. Material and Finish: Stainless steel, No. 4 finish (satin).
6. Basis of Design: Bobrick B-76867.

C. Paper Towel (Folded) Dispenser:

1. Mounting: Surface mounted.
2. Minimum Capacity: 400 C-fold or 525 multifold towels.
3. Material and Finish: Stainless steel, No. 4 finish (satin).
4. Lockset: Tumbler type.
5. Refill Indicators: Pierced slots at sides or front.
6. Basis of Design: Bobrick B-262.

D. Combination Towel (Folded) Dispenser/Waste Receptacle:

1. Description: Combination unit for dispensing C-fold or multifold towels, with removable waste receptacle.
2. Mounting: Recessed.
 - a. Designed for nominal 4-inch 6-inch wall depth.
3. Minimum Towel-Dispenser Capacity: 600 C-fold or 800 multifold paper towels.
4. Minimum Waste-Receptacle Capacity: 4 gal.
5. Material and Finish: Stainless steel, No. 4 finish (satin).
6. Liner: Reusable, vinyl waste-receptacle liner.
7. Lockset: Tumbler type for towel-dispenser compartment.
8. Basis of Design: Bobrick B-3942.

E. Liquid-Soap Dispenser:

1. Description: Designed for dispensing soap in liquid or lotion form.
2. Mounting: Horizontally oriented, surface mounted and counter mounted.
3. Capacity: Manufacturer's standard.
4. Materials: Stainless steel, No. 4 finish (satin).
5. Lockset: Tumbler type.
6. Refill Indicator: Window type.
7. Basis of Design: Bobrick B-2112 and B-8221.

F. Grab Bar:

1. Mounting: Flanges with concealed fasteners.
2. Material: Stainless steel, 0.05 inch thick.

- a. Finish: Smooth, No. 4, satin finish on ends and slip-resistant texture in grip area.
 - 3. Outside Diameter: 1-1/4 inches.
 - 4. Configuration and Length: As indicated on Drawings.
- G. Mirror Unit:
 - 1. Frame: Stainless-steel channel.
 - a. Corners: Manufacturer's standard.
 - 2. Hangers: Produce rigid, tamper- and theft-resistant installation, using method indicated below.
 - a. Wall bracket of galvanized steel, equipped with concealed locking devices requiring a special tool to remove.
 - 3. Size: 24"x48".
 - 4. Basis of Design: Bobrick B-165.
- H. Sanitary-Napkin Disposal Unit:
 - 1. Mounting: Partition mounted dual access and surface mounted.
 - 2. Door or Cover: Self-closing disposal-opening cover and hinged face panel with tumbler lockset.
 - 3. Receptacle: Removable.
 - 4. Material and Finish: Stainless steel, No. 4 finish (satin).
 - 5. Basis of Design: Bobrick B-270.

2.3 UNDERLAVATORY GUARDS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Plumberex Specialty Products, Inc.
 - 2. TCI Products.
 - 3. Truebro, Inc.
- B. Underlavatory Guard:
 - 1. Description: Insulating pipe covering for supply and drain piping assemblies, that prevent direct contact with and burns from piping, and allow service access without removing coverings.
 - 2. Material and Finish: Antimicrobial, molded-plastic, white.

2.4 CUSTODIAL ACCESSORIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. A & J Washroom Accessories, Inc.
2. American Specialties, Inc.
3. Bobrick Washroom Equipment, Inc.
4. Bradley Corporation.
5. General Accessory Manufacturing Co. (GAMCO).

B. Mop and Broom Holder:

1. Description: Unit with shelf, hooks, holders, and rod suspended beneath shelf Insert description.
2. Length: 36 inches.
3. Hooks: Three.
4. Mop/Broom Holders: Four, spring-loaded, rubber hat, cam type.
5. Material and Finish: Stainless steel, No. 4 finish (satin).
 - a. Shelf: Not less than nominal 0.05-inch- thick stainless steel.
 - b. Rod: Approximately 1/4-inch- diameter stainless steel.
6. Basis of Design: Bobrick B-239x34.

2.5 SHOWER ROOM ACCESSORIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. A & J Washroom Accessories, Inc.
2. American Specialties, Inc.
3. Bobrick Washroom Equipment, Inc.
4. Bradley Corporation.
5. General Accessory Manufacturing Co. (GAMCO).

B. Shower Curtain Rod:

1. Description: 1-inch OD; fabricated from nominal 0.0375-inch- thick stainless steel.
2. Mounting Flanges: Stainless-steel flanges designed for exposed fasteners.
3. Finish: No. 4 (satin).

C. Shower Curtain:

1. Size: Minimum 12 inches wider than opening by 84 inches high.
2. Material: Vinyl, minimum 0.006-inch- thick, opaque, matte.
3. Color: White.
4. Grommets: Corrosion resistant at minimum 6 inches o.c. through top hem.
5. Shower Curtain Hooks: Chrome-plated or stainless-steel, spring wire curtain hooks with snap fasteners, sized to accommodate specified curtain rod. Provide one hook per curtain grommet.

D. Robe Hook:

1. Description: Single-prong unit.
2. Material and Finish: Stainless steel, No. 4 finish (satin).

3. Basis of Design: Bobrick B-76727

E. Towel Bar:

1. Description: 3/4-inch-round tube with circular end brackets.
2. Mounting: Flanges with concealed fasteners.
3. Length: 24 inches.
4. Material and Finish: Stainless steel, No. 4 finish (satin).

F. Folding Shower Seat:

1. Basis-of-Design Product: Bobrick B-5181.
2. Configuration: L-shaped seat, designed for wheelchair access.
3. Seat: Phenolic or polymeric composite of slat-type or one-piece construction in color as selected by Design Professional.
4. Mounting Mechanism: Stainless steel, No. 4 finish (satin).

2.6 FABRICATION

- A. General: Fabricate units with tight seams and joints, and exposed edges rolled. Hang doors and access panels with full-length, continuous hinges. Equip units for concealed anchorage and with corrosion-resistant backing plates.
- B. Keys: Provide universal keys for internal access to accessories for servicing and resupplying. Provide minimum of six keys to Owner's representative.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install accessories according to manufacturers' written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.
- B. Grab Bars: Install to withstand a downward load of at least 250 lbf, when tested according to method in ASTM F 446.

3.2 ADJUSTING AND CLEANING

- A. Adjust accessories for unencumbered, smooth operation. Replace damaged or defective items.
- B. Remove temporary labels and protective coatings.
- C. Clean and polish exposed surfaces according to manufacturer's written recommendations.

END OF SECTION 102800

SECTION 104416 - FIRE-PROTECTION SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Portable fire extinguishers.
 - 2. Mounting brackets for fire extinguishers.
 - 3. Fire extinguisher cabinets.
- B. Related Sections include the following:
 - 1. Division 7 Section "Through-Penetration Firestop Systems" for firestopping sealants at fire-rated cabinets.

1.3 SUBMITTALS

- A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for fire-protection cabinets.
 - 1. Fire Extinguishers: Include rating and classification.
 - 2. Fire-Protection Cabinets: Include roughing-in dimensions, details showing mounting methods, relationships of box and trim to surrounding construction, door hardware, cabinet type, trim style, and panel style.
- B. Samples for Initial Selection: For fire-protection cabinets with factory-applied color finishes.
- C. Samples for Verification: For each type of exposed factory-applied color finish required for fire-protection cabinets, prepared on Samples of size indicated below.
 - 1. Size: 6 by 6 inches square.
- D. Maintenance Data: For fire extinguishers and fire-protection cabinets to include in maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain fire extinguishers and fire-protection cabinets through one source from a single manufacturer.

- B. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."
- C. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.
 - 1. Provide fire extinguishers approved, listed, and labeled by FMG.
- D. Fire-Rated Fire-Protection Cabinets: Listed and labeled to comply with requirements of ASTM E 814 for fire-resistance rating of walls where they are installed.

1.5 COORDINATION

- A. Coordinate size of fire-protection cabinets to ensure that type and capacity of fire extinguishers indicated are accommodated.
- B. Coordinate size of fire-protection cabinets to ensure that type and capacity of fire hoses, hose valves, and hose racks indicated are accommodated.

1.6 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of portable fire extinguishers that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Failure of hydrostatic test according to NFPA 10.
 - b. Faulty operation of valves or release levers.
 - 2. Warranty Period: Six years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 MATERIALS

- A. Stainless-Steel Sheet: ASTM A 666, Type 304.

- B. Wire Glass: ASTM C 1036, Type II, Class 1, Form 1, Quality q8, Mesh m1 (diamond), 6 mm thick.

2.3 PORTABLE FIRE EXTINGUISHERS

A. Manufacturers:

1. Amerex Corporation.
2. Ansul Incorporated.
3. Badger Fire Protection.
4. Buckeye Fire Equipment Company.
5. Fire End & Croker Corporation.
6. General Fire Extinguisher Corporation.
7. JL Industries, Inc.
8. Kidde Fyrnetics.
9. Larsen's Manufacturing Company.
10. Modern Metal Products; Div. of Technico.
11. Moon American.
12. Potter Roemer; Div. of Smith Industries, Inc.
13. Watrous; Div. of American Specialties, Inc.

- B. General: Provide fire extinguishers of type, size, and capacity for each fire-protection cabinet and mounting bracket indicated.

1. Valves: Manufacturer's standard.
2. Handles and Levers: Manufacturer's standard.
3. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B and bar coding for documenting fire extinguisher location, inspections, maintenance, and recharging.

- C. Multipurpose Dry-Chemical Type: UL-rated 2-A:10-B:C, 5-lb nominal capacity, with monoammonium phosphate-based dry chemical in manufacturer's standard enameled container.

2.4 FIRE-PROTECTION CABINET

A. Manufacturers:

1. Fire End & Croker Corporation.
2. General Accessory Mfg. Co.
3. JL Industries, Inc.
4. Kidde Fyrnetics.
5. Larsen's Manufacturing Company.
6. Modern Metal Products; Div. of Technico.
7. Moon American.
8. Potter Roemer; Div. of Smith Industries, Inc.
9. Watrous; Div. of American Specialties, Inc.

- B. Cabinet Type: Suitable for fire extinguisher.

- C. Cabinet Construction: 1-hour fire rated.
- D. Cabinet Material: Stainless-steel sheet.
 - 1. Shelf: Same metal and finish as cabinet.
- E. Semirecessed Cabinet: Cabinet box partially recessed in walls of shallow depth to suit style of trim indicated; with one-piece combination trim and perimeter door frame overlapping surrounding wall surface with exposed trim face and wall return at outer edge (backbend).
 - 1. Rolled-Edge Trim: 2-1/2-inch backbend depth.
- F. Cabinet Trim Material: Stainless-steel sheet.
- G. Door Material: Stainless-steel sheet.
- H. Door Style: Fully glazed panel with frame.
- I. Door Glazing: Wire glass.
- J. Door Hardware: Manufacturer's standard door-operating hardware of proper type for cabinet type, trim style, and door material and style indicated.
 - 1. Provide manufacturer's standard.
 - 2. Provide manufacturer's standard hinge permitting door to open 180 degrees.
- K. Accessories:
 - 1. Mounting Bracket: Manufacturer's standard steel, designed to secure fire extinguisher to fire-protection cabinet, of sizes required for types and capacities of fire extinguishers indicated, with plated or baked-enamel finish.
 - 2. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated by Design Professional.
 - a. Identify fire extinguisher in fire-protection cabinet with the words "FIRE EXTINGUISHER."
 - 1) Location: Applied to cabinet glazing.
 - 2) Application Process: Silk-screened, Engraved, Decals.
 - 3) Lettering Color: Red.
 - 4) Orientation: Vertical.
- L. Finishes:
 - 1. Stainless Steel: Satin finish.

2.5 MOUNTING BRACKETS

- A. Manufacturers:
 - 1. Amerex Corporation.

2. Ansul Incorporated.
3. Badger Fire Protection.
4. Buckeye Fire Equipment Company.
5. Fire End & Croker Corporation.
6. General Fire Extinguisher Corporation.
7. JL Industries, Inc.
8. Larsen's Manufacturing Company.
9. Potter Roemer; Div. of Smith Industries, Inc.

B. Mounting Brackets: Manufacturer's standard galvanized steel, designed to secure fire extinguisher to wall or structure, of sizes required for types and capacities of fire extinguishers indicated, with plated or baked-enamel finish.

1. Color: Black.

2.6 FABRICATION

A. Fire-Protection Cabinets: Provide manufacturer's standard box (tub), with trim, frame, door, and hardware to suit cabinet type, trim style, and door style indicated.

1. Weld joints and grind smooth.
2. Construct fire-rated cabinets with double walls fabricated from 0.0428-inch- thick, cold-rolled steel sheet lined with minimum 5/8-inch- thick, fire-barrier material.

- a. Provide factory-drilled mounting holes.

B. Cabinet Doors: Fabricate doors according to manufacturer's standards, from materials indicated and coordinated with cabinet types and trim styles selected.

1. Fabricate door frames with tubular stiles and rails and hollow-metal design, minimum 1/2 inch thick.
2. Miter and weld perimeter door frames.

C. Cabinet Trim: Fabricate cabinet trim in one piece with corners mitered, welded, and ground smooth.

2.7 FINISHES, GENERAL

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Finish fire-protection cabinets after assembly.

D. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are

acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.8 STAINLESS-STEEL FINISHES

- A. General: Remove tool and die marks and stretch lines or blend into finish.
 - 1. Grind and polish surfaces to produce uniform, directionally textured, polished finish indicated, free of cross scratches. Run grain with long dimension of each piece.
- B. Satin, Directional Polish: No. 6 finish.
- C. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine walls and partitions for suitable framing depth and blocking where semi-recessed cabinets will be installed.
- B. Examine fire extinguishers for proper charging and tagging.
 - 1. Remove and replace damaged, defective, or undercharged units.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Prepare recesses for semi-recessed fire-protection cabinets as required by type and size of cabinet and trim style.

3.3 INSTALLATION

- A. General: Install fire-protection specialties in locations and at mounting heights indicated or, if not indicated, at heights indicated below, acceptable to authorities having jurisdiction.
 - 1. Fire-Protection Cabinets: 54 inches above finished floor to top of cabinet.
 - 2. Mounting Brackets: 54 inches above finished floor to top of fire extinguisher.
- B. Fire-Protection Cabinets: Fasten fire-protection cabinets to structure, square and plumb.
 - 1. Unless otherwise indicated, provide recessed fire-protection cabinets. If wall thickness is not adequate for recessed cabinets, provide semi-recessed fire-protection cabinets.
 - 2. Provide inside latch and lock for break-glass panels.
 - 3. Fasten mounting brackets to inside surface of fire-protection cabinets, square and plumb.

- C. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated.
- D. Identification: Apply decals vinyl lettering at locations indicated.

3.4 ADJUSTING AND CLEANING

- A. Remove temporary protective coverings and strippable films, if any, as fire-protection specialties are installed, unless otherwise indicated in manufacturer's written installation instructions.
- B. Adjust fire-protection cabinet doors to operate easily without binding. Verify that integral locking devices operate properly.
- C. On completion of fire-protection cabinet installation, clean interior and exterior surfaces as recommended by manufacturer.
- D. Touch up marred finishes, or replace fire-protection cabinets that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by fire-protection cabinet manufacturer.
- E. Replace fire-protection cabinets that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 104416

SECTION 122113 - HORIZONTAL LOUVER BLINDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following types of venetian blinds and accessories:

- 1. Miniblinds with aluminum louver slats.

1.3 DEFINITIONS

- A. Miniblind: Venetian blind with nominal 1-inch- wide louver slat.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated. Include styles, material descriptions, construction details, dimensions of individual components and profiles, features, finishes, and operating instructions.
- B. Samples for Initial Selection: For each colored component of each type of horizontal louver blind indicated.
 - 1. Include similar Samples of accessories involving color selection.
- C. Samples for Verification: For the following products, prepared on Samples from the same material to be used for the Work.
 - 1. Louver Slat: Not less than 12 inches long.
 - 2. Tapes: Full width, not less than 6 inches long.
- D. Product Certificates: For each type of horizontal louver blind product, signed by product manufacturer.
- E. Product Test Reports: For each type of horizontal louver blind product.
- F. Maintenance Data: For horizontal louver blinds to include in maintenance manuals. Include the following:
 - 1. Methods for maintaining horizontal louver blinds and finishes.

2. Precautions about cleaning materials and methods that could be detrimental to finishes and performance.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain horizontal louver blinds through one source from a single manufacturer.
- B. Fire-Test-Response Characteristics: Provide horizontal louver blinds with the fire-test-response characteristics indicated, as determined by testing identical products per test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:
 1. Flame-Resistance Ratings: Passes NFPA 701.
- C. Corded Window Covering Product Standard: Provide horizontal louver blinds complying with WCMA A 100.1.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver blinds in factory packages, marked with manufacturer and product name, fire-test-response characteristics, lead-free designation, and location of installation using same room designations indicated on Drawings and in a window treatment schedule.

1.7 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install horizontal louver blinds until construction and wet and dirty finish work in spaces, including painting, is complete and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
- B. Field Measurements: Where horizontal louver blinds are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Allow clearances for operable glazed units' operation hardware throughout the entire operating range. Notify Design Professional of discrepancies. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

1.8 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Horizontal Louver Blinds: Before installation begins, for each size, color, texture, pattern, and gloss indicated, full-size units equal to 5 percent of amount installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Horizontal Louver Blinds, Aluminum Louver Slats:
 - a. Comfortex Window Fashions.
 - b. Hunter Douglas Window Fashions.
 - c. Levolor Contract; a Newell Company; Levolor.
 - d. Springs Window Fashions Division, Inc.; Bali.
 - e. Springs Window Fashions Division, Inc.; Graber.
 - f. Verosol USA, Inc.

2.2 HORIZONTAL LOUVER BLINDS, ALUMINUM LOUVER SLATS

- A. Louver Slats: Aluminum, alloy and temper recommended by producer for type of use and finish indicated; with crowned profile and radiused corners.
 - 1. Nominal Slat Width: 1 inch for miniblinds.
 - 2. Nominal Slat Thickness: Not less than 0.008 inch.
 - 3. Slat Finish: One color as indicated.
 - a. Ionized Coating: Antistatic, dust-repellent, baked polyester finish.
- B. Headrail/Valance: Decorative, integrated headrail/valance not requiring a separate valance or end brackets for finished appearance; formed steel or extruded aluminum; long edges returned or rolled; fully enclosing operating mechanisms on three sides and ends; capacity for two (2) blinds per headrail.
 - 1. Finish Color Characteristics: Match color, texture, pattern, and gloss of louver slats as selected by Design Professional from manufacturer's full range.
- C. Bottom Rail: Formed-steel or extruded-aluminum tube, sealed with plastic or metal capped ends top contoured to match crowned shape of louver slat; with enclosed and protected ladders and tapes to prevent their contact with sill.
- D. Tilt Control: Consisting of enclosed worm gear mechanism and linkage rod, for the following operation:
 - 1. Tilt Operation: Manual with clear plastic wand.
 - 2. Length of Tilt Control: Full length of blind.
 - 3. Tilt: Full.
- E. Lift Operation: Manual, cord lock; locks pull cord to stop blind at any position in ascending or descending travel.
- F. Ladders: Evenly spaced to prevent long-term louver sag.
 - 1. For Blinds with Nominal Slat Width 1 Inch or Less: Braided string.

- a. Tape Color, Texture, and Pattern: Color, texture, and pattern as selected by Design Professional from manufacturer's full range.
- G. Valance: Two louver slats.
 - 1. Finish Color Characteristics: Match color, texture, pattern, and gloss of louver slats as selected by Design Professional from manufacturer's full range.
- H. Mounting: End mounting permitting easy removal and replacement without damaging blind or adjacent surfaces and finishes; with spacers and shims required for blind placement and alignment indicated.
 - 1. Provide intermediate support brackets if end support spacing exceeds spacing recommended by manufacturer for weight and size of blind.
- I. Hold-Down Brackets and Hooks or Pins: Manufacturer's standard, as indicated.
- J. Colors, Textures, Patterns, and Gloss: As selected by Design Professional from manufacturer's full range.
- K. Location: Provide miniblinds at all exterior windows.

2.3 HORIZONTAL LOUVER BLINDS FABRICATION

- A. Product Standard and Description: Comply with AWCMA Document 1029, unless otherwise indicated, for each horizontal louver blind designed to be self-leveling and consisting of louver slats, rails, ladders, tapes, lifting and tilting mechanisms, cord, cord lock, tilt control, and installation hardware.
- B. Concealed Components: Noncorrodible or corrosion-resistant-coated materials.
 - 1. Lifting and Tilting Mechanisms: With permanently lubricated moving parts.
- C. Unit Sizes: Obtain units fabricated in sizes to fill window and other openings as follows, measured at 74 deg F:
 - 1. Blind Units Installed between (Inside) Jamb: Width equal to 1/4 inch per side or 1/2 inch total, plus or minus 1/8 inch, less than jamb-to-jamb dimension of opening in which each blind is installed. Length equal to 1/4 inch, plus or minus 1/8 inch, less than head-to-sill dimension of opening in which each blind is installed.
- D. Installation Brackets: Designed for easy removal and reinstallation of blind, for supporting headrail, valance, and operating hardware, and for hardware position and blind mounting method indicated.
- E. Installation Fasteners: Not fewer than two fasteners per bracket, fabricated from metal noncorrosive to blind hardware and adjoining construction; type designed for securing to supporting substrate; and supporting blinds and accessories under conditions of normal use.
- F. Color-Coated Finish:

1. Metal: For components exposed to view, apply manufacturer's standard baked finish complying with manufacturer's written instructions for surface preparation including pretreatment, application, baking, and minimum dry film thickness.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, operational clearances, and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 HORIZONTAL LOUVER BLIND INSTALLATION

- A. Install blinds level and plumb and aligned with adjacent units according to manufacturer's written instructions, and located so exterior louver edges in any position are not closer than 1 inch to interior face of glass. Install intermediate support as required to prevent deflection in headrail. Allow clearances between adjacent blinds and for operating glazed opening's operation hardware, if any.
- B. Jamb Mounted: Install headrail flush with face of opening jamb and head.
- C. Head Mounted: Install headrail on face of opening head.

3.3 ADJUSTING

- A. Adjust horizontal louver blinds to operate smoothly, easily, safely, and free from binding or malfunction throughout entire operational range.

3.4 CLEANING AND PROTECTION

- A. Clean blind surfaces after installation, according to manufacturer's written instructions.
- B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that horizontal louver blinds are without damage or deterioration at time of Substantial Completion.
- C. Replace damaged blinds that cannot be repaired, in a manner approved by Design Professional, before time of Substantial Completion.

END OF SECTION 122113

**SECTION 123553.19 – WOOD LABORATORY CASEWORK
PART 1 GENERAL**

1.01 SUMMARY

A. Section Includes:

1. All cabinets and casework, including tops, ledges, supporting structures, and miscellaneous items of equipment as listed in these specifications, or equipment schedules including delivery to the building, setting in place, leveling, scribing to walls and floors as required. Furnish and install all filler panels, knee space panels and scribes as shown on drawings. Installation shall be completed by a factory certified installer.
2. Furnish and deliver all utility service outlet accessory fittings, electrical receptacles, and switches, as listed in these specifications, equipment schedules or as shown on drawings as mounted on the laboratory furniture. Items shall be furnished with supply tank nipples and lock nuts, loose in boxes and properly marked. All plumbing and electrical fittings will be packaged separately and properly marked for delivery to the appropriate contractor.
3. Furnish and deliver, packed in boxes for installation by the mechanical contractor, all laboratory sinks, cup sinks or drains, drain troughs, overflows and sink outlets with integral tailpieces, which occur above the floor and where these items are part of the equipment or listed in the specifications, equipment schedules or shown on the drawings. Integral tailpieces when required shall be in accordance with the manufacturer's standards. All tailpieces shall be furnished less the couplings required to connect them to the drain piping system.
4. Furnish service strip supports and set in place service tunnels, service turrets, supporting structures and reagent racks of the type shown on the details.
5. Remove all debris, dirt and rubbish accumulated as a result of the installation of the laboratory casework to an onsite container provided by others, leaving the premises clean and orderly.

B. Related Divisions:

- | | |
|----------------------|-------------------------------------|
| 1. Divisions 060000: | Behind-the-Wall Blocking and Studs |
| 2. Divisions 040000: | CMU |
| 3. Division 090000: | Base Molding |
| 4. Division 220000: | Plumbing |
| 5. Division 260000: | Electrical Fittings and Connections |

C. Related Publications:

1. Architectural Woodwork Institute Quality Standards, 8th Edition
2. NFPA 30 – National Fire Protection Association
3. NFPA-45 - National Fire Protection Association
4. UL - Underwriters Laboratory
5. ASTM D552 - Bending Test
6. SEFA 8W – Laboratory Furniture

1.02 BASIS OF WORK

CITY OF PIKEVILLE 0.366 MGD
WASTEWATER TREATMENT PLANT LAB BUILDING
CONSTRUCTION DOCUMENTS SUBMITTAL

123553.19 - 1

- A. This specification uses Diversified Casework (www.diversifiedcasework.com) - **Majestic Series** (reveal overlay) OAK Cabinetry as the standard of construction for wood laboratory casework. The construction standards of this product line shall provide the basis for quality and functional installation. Pricing from other manufacturers must be submitted as an alternate in order to assure quality standards are maintained.
- B. Supply all equipment in accordance with this specification. No alternates, deviations or exceptions to the specified construction or materials are allowed.
- C. As a means of maintaining the desired level of quality, any and all other manufacturers shall be submitted as an alternate to the specified product provided by Diversified Casework.
- D. The owner / owner representative reserves the right to reject qualified or alternate proposals and to award based on product value where such action assures the owner greater integrity of product.

1.03 QUALITY ASSURANCE – the following items are required components of this specification and cannot be modified.

- A. The wood laboratory furniture contractor shall also provide work tops and fume hoods to assure proper staging, shipment, and single source responsibility.
- B. Each cabinet shall be foam and shrink wrapped to ensure cabinet surfaces are protected until the time of installation. Blanket-wrap is not allowed because they do not stay with the cabinets after delivery and because they are not assured of being grease and dirt-free.
- C. SEFA Compliance and Assurance: Wood cabinets shall be capable of passing all tests contained in SEFA 8W. Documentation shall be provided showing independent testing and compliance with SEFA 8W.
- D. MAS and/or Green Guard Certification: Manufacturer shall provide current documentation proving compliance and certification with either MAS or Green Guard small-scale chamber emissions test. Wood products shall be MAS Certified Green® and/or GreenGuard® Certified.
- E. Casework shall be installed by a factory certified installer or Lifetime Warranty shall be negated to a 2-year warranty.
- F. Cabinets shall be manufactured with dowel construction placed on a maximum 63mm on-center.
- G. Cabinets shall use a minimum of 2 mechanical fasteners along with dowel construction in securing the toe-space panel.
- H. Cabinets shall use a full sub-top construction composed of a minimum of 3/4" veneer core plywood.

- I. Cabinet faces shall be vertically grain matched within door and drawer faces.
- J. Wall cabinets shall be provided with 3/4" X 4" screw strips at both the top and bottom behind the cabinet back and doweled into both cabinet sides. Screws shall be applied via pocket hole fastener systems.

1.04 SUBMITTALS

- A. Submit compliance statement with bid – see page 14 of this specification.
- B. Casework samples will be required and reviewed per specification. Samples shall be delivered, at no cost to the Design Professional or owner, to a destination set forth by the Design Professional or owner. This must be done seven (7) days before quotation deadline as a condition of approval of each bidder. Samples shall be full size, production type samples, as will be delivered for the project. Furnish the following:
 - 1. One combination drawer and cupboard base unit, including one shelf.
 - 2. One sample of all top materials shown or called for.
 - 3. Sample of all mechanical service fittings, locks, door pulls, hinges, and interior hardware.
- C. Submit shop drawings for furniture assemblies showing plans, elevations, ends, cross-sections, service run spaces, location, and type of service fittings.
 - 1. Coordinate shop drawings with other work involved.
 - 2. Provide roughing-in drawings for mechanical and electrical services when required.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. The basis of this specification is Diversified Casework (www.diversifiedcasework.com) Majestic Series. No exceptions, deviations or alternates to the specified construction or materials are allowed.
- B. Lifetime warranty: The selected manufacturer must warrant for the life of the product in the application and location installed, starting at the date of acceptance or occupancy, whichever comes first, that all products sold under the contract referenced above shall be free from defects in material and workmanship. Purchaser shall notify the manufacturer's representative immediately of any defective product. The manufacturer shall have a reasonable opportunity to inspect the goods. The purchaser shall return no product until receipt by purchaser of written shipping instructions from the manufacturer.
- C. Additional Manufacturers.
 - 1. Kewaunee
 - 2. Mott Manufacturing
 - 3. Formaspace.

- D. The Design Professional will impound the above samples of the successful manufacturer or owner to ensure that material delivered to the jobsite conforms in every respect to the samples submitted.

2.02 MATERIALS

- A. It is the intent of this specification to provide a high quality wood cabinet specifically designed for the lab environment.
- B. Hardwood shall be kiln-dried, clear, and free of defects and shall meet surface requirements as specified below.
- C. Plywood shall be of balanced construction and 3/4" 7-ply veneer core hardwood plywood for shelves, cabinet ends, tops and bottoms of base and tall cabinets; 1" 9-ply veneer core hardwood plywood for shelves over 36", bottoms of wall and upper cabinets, and tops of wall, upper and tall cabinets; nominal 1/2" 9-ply veneer core plywood for drawer body; 3/4" 3-ply particleboard core plywood for cabinet doors and drawer heads. Plywood shall meet the standards of ANSI/HPVA HP-1-2009.
- D. Casework parts shall be as defined in AWI Quality Standards, 8th Edition, 400-G-3.
- E. Exposed surfaces shall be of plain-sliced, HPVA Grade A Northern Red Oak veneers and compatible clear, defect-free Red Oak hardwood lumber. Veneers shall be selected for golden wheat color and narrow hearts of no more than 5". No split hearts are allowed. Appalachian and Southern red oak veneers are not allowed.
- F. Semi-exposed surfaces shall be plain sliced, HPVA Grade 1 Northern Red Oak veneers and compatible clear, defect-free Red Oak hardwood lumber. Appalachian and Southern red oak veneers are not allowed.
- G. Concealed surfaces shall be no less than HPVA Grade D face or Grade 3 back veneers and compatible mill option, hardwood lumber, suitable for the application.
- H. Edging for cabinet parts shall be 3 mm hardwood edging of compatible hardwood Red Oak.
- I. Hardboard shall be 1/4" thick 55 lb. density hardwood chip fiberboard formed with heat and pressure into sheets providing a hard, smooth surface.
- J. Glass used for framed sliding and swinging doors shall be 3/16" tempered glass. Glass used for unframed sliding doors, shall be 1/4" tempered glass.
- K. Drawer and door pulls shall be satin finish, zinc coated wire type, 96 mm centers, offering a comfortable hand grip, and be securely fastened to doors and drawers. Two pulls shall be required on all drawers over 24" long.
- L. Hinges shall be BHMA Grade 1 of **stainless steel**, five (5) knuckle institutional, .083" thick, offset type for all swinging doors. Hinges shall be 2-1/2" long, one (1) pair for doors under 4 ft. in height and 1-1/2 pair on doors over 4 ft. in height. Hinges are mounted with

flathead screws, so applied to door and cabinet to withstand a weight load of 150 lbs. minimum.

- M. Locks when shown or called for shall be a National Lock, 5-disc tumbler with heavy duty interchangeable cylinder. Exposed lock noses shall be dull nickel (satin). Locks shall have capacity for 200 primary key changes. Master key one level with the potential of 200 different, non-interchangeable master key groups.
- N. Roller catches shall be used on swinging doors. Catches shall have two spring-loaded polyethylene rollers and metal catch to secure doors. Double doors without locks shall have a catch on each door. Full height cases shall have 3-point latching devices. Magnetic catches are not allowed.
- O. Leg shoes shall be provided on all table legs, unless otherwise specified, to conceal leveling device. Shoes shall be 2-1/2" high and made of pliable, black rubber material. Use of a leg shoe, which does not conceal leveling device, will not be acceptable.
- P. Floor glides, where specified for movable open-leg tables, shall be a non-skid material at least 1" diameter to prevent indenting composition flooring and shall have at least a 5/8" height adjustment. Use of metal buttons will not be acceptable.
- Q. Dowels used to join frames and panels shall be fluted hardwood not less than 8 mm in diameter. Dowels shall be spaced at a maximum of 64mm on center.
- R. Shelf support clips shall be "seismic" twin pin type for mounting on interior of cabinet work. Clips shall be corrosion resistant and shall retain shelves from accidental removal. Shelves in all cabinets are adjustable on 32mm centers. Single pin support clips and surface mounted metal support strips and clips are not acceptable.
- S. Base molding and stainless steel corner clips shall be provided by others.
- T. Upright rods, cross rods and ring support rods, where specified, shall be aluminum (1/2" or 3/4" dia., as required). Rod sockets shall be aluminum, secured through table tops with lock nut and washer. Rod clamps shall be heavy duty, designed to securely hold rod assembly in any position. Use of wood rod assemblies will not be accepted.
- U. Label holders, where shown or called for, shall be stainless steel, brad-attached type with satin finish and designed for 2" x 1" cards.
- V. Number plates, where shown or called for, shall be brass brad-attached type with satin finish and indented black lettering.
- W. Sink supports, where required, shall be of a cradle type consisting of two 1-1/2" x 3/4" horizontal cleats and adjustable leveling bolts or glides. The horizontal cleats shall be supported by two 1/8" x 1-1/2" angle irons attached to the cabinet end panels.

2.03 CONSTRUCTION

- A. Open-leg Tables: Legs shall be Red Oak hardwood construction, 2-1/4" square with 1/4" radius on all corners. Legs shall be secured to the apron frame by a heavy-duty corner

bolt and a 13-gauge steel corner brace. Corner braces shall be locked into apron rails by accurately located grooves and shall be securely fastened with screws. All apron rails shall be 13/16" thick solid Red Oak. Top shall be attached using zinc coated screws through pocket holes in the apron. Leg stretchers, where required, shall be 7/8" x 2-1/2", secured with a 4" long through-bolt.

B. Base Cabinets shall consist of the following minimum construction:

1. Joinery must meet AWI Premium Grade requirements and these specifications.
2. End panels shall be multiple doweled and glued to top frame members, intermediate rails, and bottoms. Dowel spacing shall be a maximum of 64mm on center.
3. Cabinet bottoms shall be multiple doweled and glued to end panels. Dowel spacing shall be a maximum of 64mm on center.
4. Toe space shall be 4" high and fully enclosed. Toe space shall be attached with a minimum of 4 dowels and shall also be mechanically fastened to each end panel with screw fasteners.
5. Edging shall be provided on the front edges of ends, tops, bottoms, and shelves, and on all four edges of door and drawer fronts.
6. Cabinet top shall be composed of a single full sub-top composed of 3/4" veneer core plywood that has been doweled and glued to all end panels. A cutout in the top shall be provided in order to provide for ease of installation and leveling of tops.
7. Intermediate rails (3/4" x 2-1/2" hardwood per parts definition) shall be multiple doweled and glued to end panels at the front of the cabinet between drawers and between drawers and doors.
8. Screw strips (3/4" by 4" veneer core hardwood plywood) shall be located at the top and bottom behind the cabinet back and multiple doweled to the cabinet ends.
9. Hardboard cabinet backs shall be fully captured and dadoed into end panels and bottoms, with full perimeter gluing around the rear of the back. Where a removable back is indicated, it shall be an additional piece applied to cover an opening that is added to the fully captured back. (Backs are to meet the visual requirement of cabinet parts.)
10. Shelves shall be 3/4" thick in cabinets up to 36" wide, 1" thick in all cabinets over 36" wide. (Front edges of shelves are to meet the visual requirement of cabinet parts.)
11. Drawer box shall be four-sided (sub-front, sides and back), each panel made of nominal 1/2" thick, 9-ply Baltic Birch plywood and joined to adjacent panels by full glue and multiple dovetail joinery all four corners.
12. Drawer bottom (1/4" on drawers under 42" wide, 1/2" on larger drawers) shall be white faced hardboard (appearance to meet visual appearance of drawer box), dadoed into all four drawer box sides with full perimeter gluing on the underside.
13. Door and drawer heads shall be 3/4" thick plywood with edging as specified to resist warping. Reveals shall be 1/8" vertically and 1/4" horizontally between door and drawer heads and 7/16" on end panels. Face veneers shall be vertically grain matched.
14. Drawer slides shall be easily removable with a 100 lb. dynamic load rating and nylon roller bearings, powder coated surfaces, self-closing and with a hold-open feature. Slides shall be attached to the drawer box both from below and the side. File drawers shall be full extension, 150 lb. dynamic load rating mounted to the drawer sides.

C. Full Height Sliding Door Cases:

1. Shall be designed and constructed for full enclosure to assure dust proofing of the interior.
 2. Tops shall be 1" thick plywood, multiple doweled into end panels, secured with glue.
 3. A double extruded aluminum track shall be attached to the case top for suspension system when sliding doors are called for. Doors shall be suspended from an adjustable hanger and glide on nylon roller wheels. An aluminum U-channel is located on the case bottom to guide the bottom of the doors.
 4. Solid panel doors shall be 3/4" thick plywood with edging as specified.
 5. Glazed doors shall have 2-3/4" x 7/8" thick framing, mortised, tenoned, and glued. Glass shall be set into door frame and secured with a plastic retainer.
 6. Doors shall be removable without use of tools, and so designed to prevent by-passing.
 7. Shelves shall be 3/4" thick in cabinets up to 36" wide, 1" thick in all cabinets over 36" wide.
 8. To assure a rigid case, the center shelf is structurally joined to the end panels and glued.
 9. Case bottoms shall be 3/4" thick plywood, multiple doweled and glued securely to end panels.
 10. A 3" full width strip shall be doweled and mechanically fastened into the side panels of the cabinet at both top and bottom of the back and used for attaching the cabinet to wall.
 11. Toe space, 2-1/4" deep x 4" high, shall be totally enclosed by a 3/4" x 4" plywood rail.
 12. Backs in open and glazed door cases shall be 1/4" plywood; backs not exposed to view shall be 1/4" high-density fiberboard.
 13. Case interior shall be flush.
- D. Full Height Swinging Door Cases: General construction features shall be the same as for sliding door cases except for the following:
1. Doors shall overlap opening on all four sides.
 2. A 3" full width strip shall be doweled and mechanically fastened into the side panels of the cabinet at both top and bottom of the back and used for attaching cabinet to wall.
 3. Hardwood door rails shall be mitered at corners.
 4. Astragal applied to left hand door shall provide further dust proofing.
- E. Wall-Hung Sliding Door Cases: General construction features shall be the same as for full height type cases with the following exception:
1. A 3" full width strip shall be doweled and mechanically fastened into the side panels of the cabinet at both top and bottom of the back and used for attaching the cabinet to wall.
 2. Case bottoms shall be 1" thick plywood, multiple doweled and glued securely to end panels.
- F. Wall Hung Swinging Door Cases: Construction and materials shall be the same as for sliding door cases with the following exceptions:
1. Panel or glass framed doors shall be hung on 1 pair of offset institutional type hinges under 48" in height. Doors on cases 48" high shall have 1-1/2 pair of offset institutional type hinges.
 2. All doors shall overlap opening four sides.

3. A 3" full width strip shall be doweled and mechanically fastened into the side panels of the cabinet at both top and bottom of the back and used for attaching the cabinet to wall.
4. Glass doors shall use mitered corners for the hardwood stiles and rails.
5. Astragal applied to left hand door shall provide further dust proofing.

2.04 FINISH AND PERFORMANCE REQUIREMENTS

- A. Wood Surface Preparation: Prior to application of the wood finish, case and cabinet surfaces shall be smoothly sanded to remove loose fibers, scratch marks and abrasions, with all dust thoroughly removed by compressed air. Finish shall be applied to cabinet parts prior to assembly in order to assure uniform coverage.
- B. Wood Stain Color: Selected from Manufacturer's standard selection
- C. Wood Finish Application: Finishes shall be applied and cured under controlled atmospheric conditions, aided by infrared radiant heaters. Finish must be VOC-free. Finish shall be applied via a flat line, roller applied system prior to cabinet assembly in order to assure uniform coverage.
- D. Interior Wood Casework Finish: Interior surfaces shall receive a triple application of an acid, alkali, solvent, water, and abrasion resistant finish meeting AWI requirements.
- E. Exterior Wood Casework Finish: Exposed exterior surfaces, including interiors of glazed cases and open shelving, shall be provided with an acid, alkali, solvent, water, and abrasion resistant finish meeting both AWI section 1500 and SEFA 8 requirements. Finish shall be applied to cabinet parts prior to assembly in order to assure uniform coverage.

2.05 WORKSURFACES

- A. SOLID EPOXY RESIN:
 1. Sheets cast from modified 1" epoxy resin and non-asbestos inert fillers; compounded mixture cured and thermoset specifically from formulation to provide exceptional physical and chemical resistance required in medium to heavy duty laboratory environments. Color shall be black.
- B. ACCESSORIES:
 1. Provide solid epoxy resin laboratory shelving, laboratory fume hood base work surfaces, pegboards, and reagent racks where indicated.
 2. Installation Materials: Manufacturer's joint adhesive, panel adhesive, and sealants as required to suit project conditions.
- C. FABRICATION:
 1. Fabricate tops and accessories in accordance with manufacturer's recommendations, approved Shop Drawings, and SEFA 8.

2. Epoxy Resin Worksurfaces:
 - a. Thickness:
 - 1) 1 inch (25 mm) unless otherwise indicated.
 - a) Check each sheet at factory for required thickness.
 - b) Maximum variation in thickness: plus or minus 1/16 inch (1.6mm) from corner to corner.
 - b. Warpage:
 - 1) Inspect tops for warpage prior to fabrication by placing on true flat surface.
 - a) Maximum allowable warpage: 1/16-inch (1.5 mm) in 36-inch (900 mm) span or 3/16-inch (4.5 mm) in 96 inch (2400 mm) span.
 - c. Fabrication:
 - 1) Shop fabricates in longest practical lengths.
 - a) Bond joints with highly chemical resistant cement with properties and color similar to base material.
 - b) Provide 1/8-inch (3 mm) drip groove at underside of exposed edges, set back ½ inch (13 mm) from face.
 - c) Finish exposed edges.
 - d. Edge treatment:
 - 1) Standard 1/8 inch (2 mm) chamfered edge.
 - e. Corner treatment:
 - 1) Exposed corners shall be eased slightly for safety
 - f. Back and end splashes:
 - 1) Supplied loose for field installation.
 - 2) Same material and thickness as worksurfaces.
 - 3) 4 inches high unless otherwise indicated.
 - 4) Top-mounted end splash where worksurfaces abut adjacent construction and locations indicated on Drawings.
 - g. Joints:
 - 1) Maximum 1/8 inch (2 mm), bonded with epoxy grout.
 - 2) Make joints between two benches level.
 - 3) Locate joints away from sinks and over or near supports.
 - h. Sink cutouts:
 - 1) Routed for drop-in sink.
 - i. Allowable tolerances:
 - 1) Square.
 - a) Plus, or Minus 1/64 inch (0.4 mm) for each 12 inches (300 mm) of length.
 - 2) Location of cutouts and drilled openings.
 - a) Plus, or Minus 1/8 inch (3 mm) of design dimension.
 - 3) Size of cutouts and drilled openings.
 - a) Plus 1/8 inch (3 mm) or minus 0 inches (0 mm).
3. Epoxy Resin Sinks:
 - a. Mold sinks from thermosetting epoxy resin.
 - b. Mold interior corners to radius and slope sink base to drain outlet.

- 1) Provide 1-1/2 inch (38 mm) outlet with open ended standpipe.
 - a) Standpipe overflow 2 inches (50 mm) shorter than depth of sink.
- c. Unless otherwise indicated fabricate sinks of drop-in design supported by upper flange from worksurface.
 - 1) Color.
 - a) Match adjacent worksurface.

2.06 SERVICE FITTINGS AND ACCESSORIES

A. MATERIALS:

- 1. Laboratory Service Fittings:
Service fittings shall be laboratory grade, and water faucets and valve bodies shall be cast red brass alloy or bronze forgings, with a minimum content of 85%. All fittings shall be chromium plated unless specified otherwise.
- 2. Plastic Coated Finish (Sepia Bronze):
When specified, laboratory service fittings shall have an acid resistant plastic coating applied over a fine sand-blasted surface. Surfaces shall be sprayed and baked three times with a minimum thickness of .0005 to .0010 mils. (See Performance Ratings).
- 3. Service Indexes:
Fittings shall be identified with service indexes in the following color coding:
 - Hot Water Red
 - Cold Water Dark Green
 - Gas Dark Blue
 - Air Orange
 - Vacuum Yellow
 - Distilled Water.... White
 - Steam Black
 - Nitrogen Brown
 - Oxygen Light Green
 - Hydrogen Pink
 - Special Gases.... Light Blue

B. CONSTRUCTION:

- 1. Water Fittings:
Water fittings shall be provided with a renewable unit containing all operating parts which are subject to wear. The renewable unit shall contain an integral volume control device and all faucets shall be capable of being readily converted from compression to self-closing, without disturbing the faucet body proper. Four (4) arm forged brass handles shall contain plastic screw-on type colored service index buttons.
- 2. Steam Fittings:
Steam fittings shall have a black, heat resistant composition handle, and shall be the heavy pattern design with stainless steel removable seat and flat Teflon seat disc. They shall have Teflon impregnated packing, and shall be so constructed that they

can be repacked under pressure.

3. Distilled Water Fittings:
Distilled water fittings shall be chromium plated cast bronze with tin lined interior and self-closing type, or shall be made of aluminum and not be the self-closing type. Handles shall be furnished with tamper-proof and vandal resistant service indexes.
4. Laboratory Ball Valves:
Laboratory ball valves shall have a forged brass valve body with a non-removable serrated hose end and a forged brass lever-type handle with a full view color-coded index button. Valves shall have a floating chrome plated brass ball and molded TFE seals. Valves shall be certified by CSA International for use with natural gas under ANSI Z21.15./CGA9.1
5. Needle Valve Hose Cocks:
Needle type valves shall have a stainless steel replaceable floating cone, precision finished and self-centering. Cone locates against a stainless steel seat, easily removable and replaced with a socket wrench. Valve shall have "TEFLON" impregnated packing and designed so unit can be repacked while under pressure.
6. Gooseneck Type Outlets:
Gooseneck outlets shall have a separate brazed coupling to provide a full thread attachment of anti-splash, serrated tip or filter pump fittings.
7. Remote Control Valves:
All valves for remote control use shall be as previously specified, but shall be complete with aluminum extension rods, escutcheon plates, brass forged handles and screw-on type colored service index button.
8. Tank Nipples:
Tank nipples shall be provided with locking nut and washer for all fixtures where fittings are anchored to equipment.
9. Sink Outlets:
Unless otherwise specified, sink outlets for other than stainless steel sinks shall be sin, with integral cross bars, tapered for overflow and be complete with gasket and lock nut with 1-1/2" I.P.S. male straight thread outlet. Overflows shall not be furnished for sink outlets unless specifically called for.
10. Crumb Cup Strainers:
Crumb cup strainers shall be stainless steel or chromium plated brass, as specified, and shall be furnished for stainless steel sinks, and be complete with gasket, lock nut and 4" long unthreaded tailpiece outlet in 1-1/2" size.
11. Vacuum Breakers:
Vacuum breakers where required shall be "Nidel" or "Watts" unless otherwise specified or identified to be an integral part of the water fixture assembly.
12. Aerator Outlets:
Aerator type outlets shall be furnished for all gooseneck water faucets not furnished

with serrated hose connectors.

13. Waste Lines:

Waste lines shall be furnished by other trades.

14. Traps:

Traps shall be furnished by other trades.

15. Electrical Fittings:

Electrical fittings shall contain 20 Amp., 125 Volt AC, 3-wire polarized grounded receptacles, unless otherwise specified. Pedestal and line-type boxes shall be of aluminum, metallic finish with stainless steel flush plates. Receptacle boxes shall be of plated steel. All electrical or conduit fittings called for or to be furnished under these specifications shall meet the requirements of the National Electrical Code.

C. PERFORMANCE:

1. Maximum Line Pressures:

Laboratory Ball Valves (Gas and Air) ...75 PSI
Needle Point Cocks (Gas and Air)65 PSI
Vacuum.....28.5" Mercury
Hot and Cold Water.....80 PSI
Steam.....30 PSI

2. Sepia Bronze Finish Performance:

Finish shall show no rupture, other than a slight discoloration or possible softening when subjected to the following fumes for approximately six (6) days: Plastic coated fittings shall be suspended in a container, 6 cu. ft. capacity 12" above open beakers, each containing 199 cc. of 70% Nitric Acid, 94% Sulphuric Acid, 37-38% Hydrochloric Acid, respectively. Finish shall also withstand direct contact of reagents dropped from a burette at a rate of 60 drops/min. for a period of 10 minutes. Chemicals are shown below:

Concentrated Hydrochloric Acid 37-38%*
Concentrated Nitric Acid 70%*
Concentrated Sulphuric Acid 94%
Glacial Acetic Acid 99.5%*
Ethyl and Other Alcohols
Toluene and Other Hydrocarbons
Carbon - Tetrachloride
Mineral Oil

*Percentages are by weight.

D. TECHNICAL Products

BASIS OF DESIGN: 92204-ADA SHELDON AIR FOIL FUME HOOD

Hood superstructure shall be air foil design incorporating air foils at the entire perimeter of the opening of the hood. This design will provide for efficient removal

of all fumes, both heavy and light, with the least amount of turbulence of air entering the hood.

The exterior of the superstructure shall be fabricated of cold roll furniture steel finished in color selected. Exterior finish shall be chemical resistant two part epoxy finish. The interior shall be poly resin liner.

The inner lining and exterior finished panels are attached to a framework constructed of 16 and 18 gauge steel. This framework is welded and bolted together to form a rigid assembly and is painted with a black rust inhibitive finish. All steel parts are tested with an iron phosphate bath to resist corrosion and insure adhesion to finish materials. The inner lining material is securely fastened to this frame assembly.

Vertical sliding sash is constructed of 18 gauge steel, welded into a rigid frame, and has removable glass retainers for reglazing. A flush, full length finger lift is located at the bottom of the sash. Nylon glides are located on each side. Sash guides are stainless steel. The sash is glazed with 7/32" clear laminated safety glass set in a "U" shaped neoprene channel. The sash is counter balanced using a single weight at the rear of the hood, and is attached to the sash with 1/16", 7x7 plastic coated aircraft-type cable; total diameter, 105". Cables ride on six 2" diameter nylon ball bearing pulleys.

Base cabinet is wood with a 1" thick, dished, black epoxy resin work surface.

Electrical services include fluorescent vapor proof light fixture (bulbs not included), light switch, blower switch, and (2) duplex electrical outlets.

Plumbing services include (1) remote controlled cold water gooseneck faucet, (1) remote controlled gas, (1) remote controlled air and (1) remote controlled vacuum fixture. All plumbing fixtures shall have a powder coat finish for maximum chemical resistance.

833 CFM @ 100 f.p.m.

.25 Static Pressure at Fume Hood Duct Collar. {(1) 10-inch duct}

1. ADDITIONAL MANUFACTURERS:
 - A. FORMASPACE
 - B. LABCONCO
 - C. FISHER SCIENTIFIC

PART 3 EXECUTION

3.01 SITE EXAMINATION

- A. The owner and/or his representative shall assure all building conditions conducive to the installation of a finished goods product; all critical dimensions and conditions previously checked have been adhered to by other contractors (general, mechanical, electrical, etc.) to assure a quality installation.
- B. Site conditions shall be in compliance with AWS Edition 1, Section 2.

3.02 INSTALLATION

- A. Installer: Installer shall be certified by the factory as having the necessary skills and equipment to install the casework so as not to void the warranty.
- B. Installation shall be to the standards set forth in SEFA 2 -2010 Installation.
- C. Preparation: Prior to beginning installation of casework, check and verify that no irregularities exist that would affect quality of execution of work specified.
- D. Coordination: Coordinate the work of the Section with the schedule and other requirements of other work being performed in the area at the same time both with regard to mechanical and electrical connections to and in the fume hoods and the general construction work.
- E. Performance:
 - 1. Casework:
 - a. Set casework components plumb, square, and straight with no distortion and securely anchor to building structure. Shim as required using concealed shims.
 - b. Screw continuous cabinets together with joints flush, tight and uniform, and with alignment of adjacent units within 1/16" tolerance.
 - c. Secure wall cabinets to solid supporting material, not to plaster, lath or gypsum board.
 - d. Abut top edge surfaces in one true plane. Provide flush joints not to exceed 1/8" between top units.
 - 2. Work surfaces:
 - a. Where required due to field conditions, scribe to abutting surfaces.
 - b. Only factory prepared field joints, located per approved shop drawings, shall be permitted. Secure the joints in the field, where practical, in the same manner as in the factory.
 - c. Secure work surfaces to casework and equipment components with materials and procedures recommended by the manufacturer.
 - 3. Adjust and Clean:
 - a. Repair or remove and replace defective work, as directed by owner and/or his representative upon completion of installation.
 - b. Adjust doors, drawers and other moving or operating parts to function smoothly.
 - c. Clean shop finished casework; touch up as required.
 - d. Clean work surfaces and leave them free of all grease and streaks.
 - e. Casework to be left broom clean and orderly.
- F. Protection:
 - 1. Provide reasonable protective measures to prevent casework and equipment from being exposed to other construction activity.

2. Advise owner and/or his representative of procedures and precautions for protection of material, installed laboratory casework, and fixtures from damage by work of other trade.

END OF SECTION 123553.19

SECTION 123553 - LABORATORY CASEWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Wood laboratory casework.
2. Utility-space framing at backs of base cabinets and between backs of base cabinets.
3. Filler and closure panels.
4. Laboratory casework system that includes support and utility-space framing, filler and closure panels, wall panels, undercabinet lighting, and modular countertops.
5. Laboratory countertops.
6. Tables.
7. Shelves.
8. Laboratory sinks and troughs.
9. Laboratory accessories.
10. Water, laboratory gas, and electrical service fittings.

B. Related Sections:

1. Division 06 Section "Rough Carpentry" for wood framed partitions and blocking for anchoring laboratory casework.
2. Divisions 22 and 26 Sections for installing service fittings specified in this Section, including connecting service utilities.

1.3 DEFINITIONS

- A. MDF: Medium-density fiberboard.

- B. Exposed Surfaces of Casework: Surfaces visible when doors and drawers are closed, including bottoms of cabinets more than 48 inches above floor, and visible surfaces in open cabinets or behind glass doors.

1. Ends of cabinets, including those installed directly against walls or other cabinets, are defined as "exposed."
2. Ends of cabinets indicated to be installed directly against and completely concealed by walls or other cabinets are defined as "concealed."

- C. Semiexposed Surfaces of Casework: Surfaces behind opaque doors, such as cabinet interiors, shelves, and dividers; interiors and sides of drawers; and interior faces of doors. Tops of cabinets 78 inches or more above floor are defined as "semiexposed."
- D. Concealed Surfaces of Casework: Include sleepers, web frames, dust panels, and other surfaces not usually visible after installation.
- E. Hardwood Plywood: A panel product composed of layers or plies of veneer, or of veneers in combination with lumber core, hardboard core, MDF core, or particleboard core, joined with adhesive and faced both front and back with hardwood veneers.

1.4 PERFORMANCE REQUIREMENTS

- A. System Structural Performance: Laboratory casework and support framing system shall withstand the effects of the following gravity loads and stresses without permanent deformation, excessive deflection, or binding of drawers and doors:
 - 1. Support Framing System: 600 lb/ft..
 - 2. Suspended Base Cabinets (Internal Load): 160 lb/ft..
 - 3. Work Surfaces (Including Tops of Suspended Base Cabinets): 160 lb/ft..
 - 4. Wall Cabinets (Upper Cabinets): 160 lb/ft..
 - 5. Shelves: 40 lb/sq. ft..
- B. Delegated Design: Design laboratory casework, including comprehensive engineering analysis by a qualified professional engineer, using seismic performance requirements and design criteria indicated.
- C. Seismic Performance: Laboratory casework and support framing system , including attachments to other work, shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.

1.5 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For laboratory casework. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Indicate locations of hardware and keying of locks.
 - 2. Indicate locations and types of service fittings.
 - 3. Indicate locations of blocking and reinforcements required for installing laboratory casework.
 - 4. Include details of utility spaces showing supports for conduits and piping.
 - 5. Include details of support framing system.
 - 6. Include details of exposed conduits, if required, for service fittings.
 - 7. Indicate locations of and clearances from adjacent walls, doors, windows, other building components, and other laboratory equipment.
 - 8. Include coordinated dimensions for laboratory equipment specified in other Sections.

- C. Samples for Initial Selection: For factory-applied finishes and other materials requiring color selection.
- D. Samples for Verification: For each type of cabinet finish and each type of countertop material indicated, in manufacturer's standard sizes.
- E. Delegated-Design Submittal: For laboratory casework indicated to comply with seismic performance requirements, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- F. Qualification Data: For qualified manufacturer.
- G. Product Test Reports for Casework: Based on evaluation of comprehensive tests performed by a qualified testing agency, indicating compliance of laboratory casework with requirements of specified product standard and system structural performance specified in "Performance Requirements" Article.
- H. Product Test Reports for Countertop Surface Material: Based on evaluation of comprehensive tests performed by a qualified testing agency, indicating compliance of laboratory countertop surface materials with requirements specified for chemical and physical resistance.

1.6 QUALITY ASSURANCE

- A. Source Limitations: Obtain laboratory casework from single source from single manufacturer unless otherwise indicated.
 - 1. Obtain countertops, sinks, accessories and service fittings from casework manufacturer.
- B. Product Designations: Drawings indicate sizes and configurations of laboratory casework by referencing designated manufacturer's catalog numbers. Other manufacturers' laboratory casework of similar sizes and similar door and drawer configurations and complying with the Specifications may be considered. Refer to Division 01 Section "Product Requirements."
- C. Casework Product Standard: Comply with SEFA 8, "Laboratory Furniture - Casework, Shelving and Tables - Recommended Practices."
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- E. Preinstallation Conference: Conduct conference at Project site.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Protect finished surfaces during handling and installation with protective covering of polyethylene film or other suitable material.

1.8 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install laboratory casework until building is enclosed, utility roughing-in and wet work are complete and dry, and temporary HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.

1.9 COORDINATION

- A. Coordinate layout and installation of framing and reinforcements for support of laboratory casework.
- B. Coordinate installation of laboratory casework with installation of fume hoods and other laboratory equipment.

1.10 EXTRA MATERIALS

- A. Furnish complete touchup kit for each type and color of metal laboratory casework provided. Include fillers, primers, paints, and other materials necessary to perform permanent repairs to damaged laboratory casework finish.
- B. Furnish complete touchup kit for each type and color of wood laboratory casework provided. Include scratch fillers, stains, finishes, and other materials necessary to perform permanent repairs to damaged laboratory casework finish.
- C. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Cabinet Mounting Clips and Related Hardware: Quantity equal to 5 percent of amount installed, but no fewer than 20 of each type.
 - 2. Modular Countertop Units: Two extra units of each length and material installed.

PART 2 - PRODUCTS

2.1 WOOD CABINET AND TABLE MATERIALS

- A. General:
 - 1. Adhesives: Do not use adhesives that contain urea formaldehyde.
 - 2. Maximum Moisture Content for Lumber: 7 percent for hardwood and 12 percent for softwood.
 - 3. Hardwood Plywood: HPVA HP-1, either veneer core or particleboard core, unless otherwise indicated, made without urea formaldehyde.
 - 4. Hardboard: AHA A135.4, Class 1 Tempered.
 - 5. Edgebanding for Wood-Veneered Construction: Minimum 1/8-inch- thick, solid wood of same species as face veneer.

B. Exposed Materials:

1. General: Provide materials that are selected and arranged for compatible grain and color. Do not use materials adjacent to one another that are noticeably dissimilar in color, grain, figure, or natural character markings.
2. Wood Species: Red Oak.
3. Plywood: Hardwood plywood with face veneer of species indicated, selected for compatible color and grain. Grade A exposed faces at least 1/50 inch thick, and Grade J crossbands. Provide backs of same species as faces.
 - a. Face Veneer Cut: Plain sliced.
4. Solid Wood: Clear hardwood lumber of species indicated and selected for grain and color compatible with exposed hardwood plywood.

C. Semiexposed Materials:

1. Solid Wood: Sound hardwood lumber, selected to eliminate appearance defects, of same species as exposed solid wood.
2. Plywood: Hardwood plywood of same species as exposed plywood. Grade B faces and Grade J crossbands. Provide backs of same species as faces.
3. Provide solid wood or hardwood plywood for semiexposed surfaces unless otherwise indicated.
4. Metal for Steel Drawer Pans: Cold-rolled, carbon-steel sheet complying with ASTM A 1008/A 1008M; matte finish; suitable for exposed applications.

D. Concealed Materials:

1. Solid Wood: Any species, with no defects affecting strength or utility.
2. Plywood: Hardwood plywood. Provide backs of same species as faces.

2.2 COUNTERTOP TABLE TOP, SHELF, TROUGH AND SINK MATERIALS

A. Epoxy: Factory-molded, modified epoxy-resin formulation with smooth, nonspecular finish.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Durcon Company (The).
 - b. Epoxyn Products.
 - c. Laboratory Tops, Inc.
 - d. Prime industries, inc.
2. Physical Properties:
 - a. Flexural Strength: Not less than 10,000 psi.
 - b. Modulus of Elasticity: Not less than 2,000,000 psi.
 - c. Hardness (Rockwell M): Not less than 100.
 - d. Water Absorption (24 Hours): Not more than 0.02 percent.
 - e. Heat Distortion Point: Not less than 260 deg F.

3. Chemical Resistance: Epoxy-resin material has the following ratings when tested with indicated reagents according to NEMA LD 3, Test Procedure 3.4.5:
 - a. No Effect: Acetic acid (98 percent), acetone, ammonium hydroxide (28 percent), benzene, carbon tetrachloride, dimethyl formamide, ethyl acetate, ethyl alcohol, ethyl ether, methyl alcohol, nitric acid (70 percent), phenol, sulfuric acid (60 percent), and toluene.
 - b. Slight Effect: Chromic acid (60 percent) and sodium hydroxide (50 percent).
4. Color: Black.

2.3 WOOD CABINETS AND TABLES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Fisher Hamilton L.L.C.
 2. Kewaunee Scientific Corporation; Laboratory Products Group.
 3. Leonard Peterson & Company, Inc.
 4. Sheldon Laboratory Systems.
- B. Design: Reveal overlay with square edges.
- C. Veneer Matching:
 1. None required; select and arrange veneers for compatible grain and color.
- D. Construction: Provide wood-faced laboratory casework of the following minimum construction:
 1. Bottoms of Base Cabinets and Tall Cabinets: 3/4-inch- thick hardwood plywood.
 2. Tops and Bottoms of Wall Cabinets and Tops of Tall Cabinets: 1-inch- thick veneer-core hardwood plywood.
 3. Ends of Cabinets: 3/4-inch- thick hardwood plywood.
 4. Shelves: 1-inch- thick hardwood plywood.
 5. Base Cabinet Top Frames: 3/4-by-2-inch solid wood with mortise and tenon or doweled connections, glued and pinned or screwed.
 6. Base Cabinet Stretchers: 3/4-by-4-1/2-inch panel product strips or solid wood boards at front and back of cabinet, glued and pinned or screwed.
 7. Backs of Cabinets: 3/4-inch- thick, hardwood plywood where exposed, 1/2-inch- thick, hardwood plywood dadoed into sides, bottoms, and tops where not exposed.
 8. Drawer Fronts: 3/4-inch- thick, hardwood plywood or solid hardwood.
 9. Drawer Sides and Backs: 1/2-inch- thick, solid hardwood or hardwood plywood, with glued dovetail or multiple-dowel joints.
 10. Drawer Bottoms: 1/4-inch- thick, veneer-core hardwood plywood glued and dadoed into front, back, and sides of drawers. Use 1/2-inch- thick material for drawers more than 24 inches wide.
 11. Doors 48 Inches High or Less]: 3/4 inch thick, solid hardwood or hardwood plywood.

- E. Tables: Manufacturer standard metal legs and shelving frame to match existing. Provide baked enamel finish. Provide leveling device at bottom of each leg.
- F. Utility-Space Framing: Laboratory casework manufacturer's standard steel framing units consisting of 2 steel slotted channels complying with MFMA-4, not less than 1-5/8 inches square by 0.105-inch nominal thickness, and connected at top and bottom by U-shaped brackets made from 1-1/4-by-1/4-inch steel flat bars. Framing units may be made by welding specified channel material into rectangular frames instead of using U-shaped brackets.
- G. Filler and Closure Panels: Provide where indicated and as needed to close spaces between cabinets and walls, ceilings, and indicated equipment. Fabricate from same material and with same finish as adjacent exposed cabinet surfaces unless otherwise indicated.
 - 1. Provide utility-space closure panels at spaces between base cabinets where utility space would otherwise be exposed, including spaces below countertops.
 - 2. Provide closure panels at ends of utility spaces where utility space would otherwise be exposed.
 - 3. Provide knee-space panels (modesty panels) at spaces between base cabinets, where cabinets are not installed against a wall or where space is not otherwise closed. Fabricate from same material and with same finish as exposed cabinet backs.

2.4 LABORATORY CASEWORK SYSTEM

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Fisher Hamilton L.L.C.
 - 2. Kewaunee Scientific Corporation; Laboratory Product Group.
 - 3. Sheldon Laboratory Systems
 - 4. Leonard Peterson.
- B. Provide casework manufacturer's standard integrated system that includes support framing, suspended modular cabinets, filler and closure panels, wall panels, undercabinet task-lighting fixtures, countertops, and fittings needed to assemble system. System includes hardware and fasteners for securing support framing to permanent construction.
 - 1. Cabinet Construction: Wood.
 - 2. Cabinets can be removed and reinstalled without use of special tools for relocation within system.
 - 3. Base cabinets can be removed without providing temporary support for, or removing, countertops.
 - 4. Sinks are supported independent of base cabinets.
 - 5. Support framing has provision for fastening pipe supports at utility space in not more than 1-inch increments.
 - 6. System includes filler and closure panels to close spaces between support framing, cabinets, shelves, countertops, floors, and walls unless otherwise indicated. Fabricate panels from same material and with same finish as metal cabinets and with hemmed or flanged edges.

- C. Support Framing: Casework manufacturer's standard system consisting of vertical supports and connecting braces and rails as follows:
 - 1. Cabinets, shelves, and countertops are supported from vertical supports except where floor-supported base cabinets are indicated. Vertical positioning of supported cabinets, shelves, and countertops can be varied in 1-inch increments through full height of supports.
- D. Undercabinet Task-Light Fixtures: Single-tube fluorescent fixtures with switch and heavy-duty cord and plug.
 - 1. Finish: Baked enamel.
 - 2. Diffusers: Virgin acrylic with high resistance to yellowing and other changes due to aging, heat, and UV radiation.
 - 3. Ballast Sound Rating: A.
- E. Countertops: Provide in modular lengths indicated, without seams.

2.5 WOOD FINISH

- A. Preparation: Sand lumber and plywood before assembling. Sand edges of doors, drawer fronts, and molded shapes with profile-edge sander. Sand after assembling for uniform smoothness at least equivalent to that produced by 220-grit sanding and without machine marks, cross sanding, or other surface blemishes.
- B. Staining: Remove fibers and dust and apply stain to exposed and semiexposed surfaces as necessary to match approved Samples. Apply stain in a manner that will produce a consistent appearance. Apply wash-coat sealer before applying stain to closed-grain wood species.
- C. Chemical-Resistant Finish: Apply laboratory casework manufacturer's standard two-coat, chemical-resistant, transparent finish. Sand and wipe clean between coats. Topcoat(s) may be omitted on concealed surfaces.

2.6 HARDWARE

- A. General: Provide laboratory casework manufacturer's standard, commercial-quality, heavy-duty hardware complying with requirements indicated for each type.
- B. Hinges: Epoxy-coated steel, 5-knuckle hinges complying with BHMA A156.9, Grade 1, with antifriction bearings and rounded tips. Provide 2 for doors 48 inches high or less and 3 for doors more than 48 inches high.
- C. Hinged Door and Drawer Pulls: Epoxy-coated steel back-mounted pulls. Provide 2 pulls for drawers more than 24 inches wide.
 - 1. Design: Match existing.
 - 2. Overall Size: Match existing.

- D. Door Catches: Nylon-roller spring catches. Provide 2 catches on doors more than 48 inches high.
- E. Drawer Slides: Side mounted, epoxy-coated steel, self-closing; designed to prevent rebound when drawers are closed; complying with BHMA A156.9, Type B05091.
 - 1. Provide Grade 1HD-100; for drawers not more than 6 inches high and 24 inches wide.
 - 2. Provide Grade 1HD-100; for drawers more than 6 inches high or 24 inches wide.
 - 3. Heavy Duty (Grade 1HD-100 and Grade 1HD-200): Full-overtravel-extension, ball-bearing type.
- F. Label Holders: Stainless steel, aluminum, or chrome plated; sized to receive standard label cards approximately 1 by 2 inches, attached with screws or rivets. Provide on all drawers.
- G. Locks for Wood Cabinets: Cam type with 5-pin tumbler, brass with chrome-plated finish; complying with BHMA A156.11, Type E07281 or E07261.
 - 1. Provide a minimum of two keys per lock and two master keys.
 - 2. Provide on all drawers and doors.
 - 3. Keying: Compatible with existing locks.
 - 4. Master Key System: Key all locks to be operable by existing master key.
- H. Adjustable Shelf Supports for Wood Cabinets: Powder-coated steel shelf rests complying with BHMA A156.9, Type B04013.
- I. Adjustable Wall Shelf Supports: Surface-type steel standards and steel shelf brackets, with epoxy powder-coated finish, complying with BHMA A156.9, Types B04102 and B04112.

2.7 COUNTERTOPS, TABLE TOPS , SHELVES , TROUGHES, AND SINKS

- A. Countertops, General: Provide units with smooth surfaces in uniform plane free of defects. Make exposed edges and corners straight and uniformly beveled. Provide front and end overhang of 1 inch, with continuous drip groove on underside 1/2 inch from edge.
- B. Sinks, General: Provide sizes indicated or laboratory casework manufacturer's closest standard size of equal or greater volume, as approved by Design Professional.
 - 1. Outlets: Provide with strainers and tailpieces, NPS 1-1/2, unless otherwise indicated.
 - 2. Overflows: Provide overflow of standard beehive or open-top design with separate strainer. Height 2 inches less than sink depth. Provide in same material as strainer.
- C. Epoxy Countertop, Table Tops, and Sinks:
 - 1. Countertop Fabrication: Fabricate with factory cutouts for sinks, holes for service fittings and accessories, and with butt joints assembled with epoxy adhesive and concealed metal splines.
 - a. Countertop Configuration: Marine edge.
 - b. Countertop Construction: Uniform throughout full thickness.

2. Table-Top Fabrication:
 - a. Table-Top Configuration: Marine edge.
 - b. Table-Top Construction: Uniform throughout full thickness.

3. Sink Fabrication: Molded in 1 piece with smooth surfaces, coved corners, and bottom sloped to outlet; 1/2-inch minimum thickness.
 - a. Provide with polypropylene strainers and tailpieces.
 - b. Provide integral sinks in epoxy countertops, bonded to countertops with invisible joint line.
 - c. Provide manufacturer's recommended adjustable support system for table- and cabinet-type installations.

2.8 LABORATORY ACCESSORIES

- A. Reagent Shelves: Provide as indicated, fabricated from same material as adjacent countertop, unless otherwise indicated.

- B. Pegboards: Polypropylene, epoxy, or phenolic-composite pegboards with removable polypropylene pegs and stainless-steel drip troughs with drain outlet.

2.9 WATER AND LABORATORY GAS SERVICE FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Broen A/S.
 2. Chicago Faucet Company (The); a Geberit company.
 3. WaterSaver Faucet Co.

- B. Service Fittings: Provide units that comply with SEFA 7, "Laboratory and Hospital Fixtures - Recommended Practices." Provide fittings complete with washers, locknuts, nipples, and other installation accessories. Include wall and deck flanges, escutcheons, handle extension rods, and similar items.
 1. Provide units that comply with "Vandal-Resistant Faucets and Fixtures" recommendations in SEFA 7.

- C. Materials: Fabricated from cast or forged red brass unless otherwise indicated.

- D. Finish: Acid- and solvent-resistant powder coating complying with requirements in SEFA 7 for corrosion-resistant finishes.
 1. Provide chemical-resistant powder coating in laboratory casework manufacturer's standard metallic brown, aluminum, white, or other color as approved by Design Professional.

- E. Water Valves and Faucets: Provide units complying with ASME A112.18.1, with renewable seats, designed for working pressure up to 80 psig.
 - 1. Vacuum Breakers: Provide ASSE 1035 vacuum breakers on water fittings with serrated outlets.
 - 2. Aerators: Provide aerators on water fittings that do not have serrated outlets.
- F. Handles: Provide three- or four-arm, forged-brass handles for valves unless otherwise indicated.
 - 1. Provide lever-type handles. Lever handle aligns with outlet when valve is closed and is perpendicular to outlet when valve is fully open.
- G. Service-Outlet Identification: Provide color-coded plastic discs with embossed identification, secured to each service-fitting handle to be tamper resistant. Comply with SEFA 7 for colors and embossed identification.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas, with Installer present, for compliance with requirements for installation tolerances, location of reinforcements, and other conditions affecting performance of laboratory casework.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF CABINETS

- A. Comply with installation requirements in SEFA 2.3. Install level, plumb, and true; shim as required, using concealed shims. Where laboratory casework abuts other finished work, apply filler strips and scribe for accurate fit, with fasteners concealed where practical. Do not exceed the following tolerances:
 - 1. Variation of Tops of Base Cabinets from Level: 1/16 inch in 10 feet.
 - 2. Variation of Bottoms of Upper Cabinets from Level: 1/8 inch in 10 feet.
 - 3. Variation of Faces of Cabinets from a True Plane: 1/8 inch in 10 feet.
 - 4. Variation of Adjacent Surfaces from a True Plane (Lippage): 1/32 inch.
 - 5. Variation in Alignment of Adjacent Door and Drawer Edges: 1/16 inch.
- B. Utility-Space Framing: Secure to floor with two fasteners at each frame. Fasten to partition framing, wood blocking, or metal reinforcements in partitions and to base cabinets.
- C. Base Cabinets: Fasten cabinets to utility-space framing, partition framing, wood blocking, or reinforcements in partitions with fasteners spaced not more than 24 inches o.c. Bolt adjacent cabinets together with joints flush, tight, and uniform.

1. Where base cabinets are installed away from walls, fasten to floor at toe space at not more than 24 inches o.c. and at sides of cabinets with not less than 2 fasteners per side.
- D. Wall Cabinets: Fasten to hanging strips, masonry, partition framing, blocking, or reinforcements in partitions. Fasten each cabinet through back, near top, at not less than 24 inches o.c.
- E. Install hardware uniformly and precisely. Set hinges snug and flat in mortises.
- F. Adjust laboratory casework and hardware so doors and drawers align and operate smoothly without warp or bind and contact points meet accurately. Lubricate operating hardware as recommended by manufacturer.

3.3 INSTALLATION OF COUNTERTOPS

- A. Comply with installation requirements in SEFA 2.3. Abut top and edge surfaces in one true plane with flush hairline joints and with internal supports placed to prevent deflection. Locate joints only where shown on Shop Drawings.
- B. Fastening:
 1. Secure epoxy countertops to cabinets with epoxy cement, applied at each corner and along perimeter edges at not more than 48 inches o.c.
 2. Where necessary to penetrate countertops with fasteners, countersink heads approximately 1/8 inch and plug hole flush with material equal to countertop in chemical resistance, hardness, and appearance.
- C. Provide required holes and cutouts for service fittings.
- D. Provide scribe moldings for closures at junctures of countertop, curb, and splash with walls as recommended by manufacturer for materials involved. Match materials and finish to adjacent laboratory casework. Use chemical-resistant, permanently elastic sealing compound where recommended by manufacturer.
- E. Carefully dress joints smooth, remove surface scratches, and clean entire surface.

3.4 INSTALLATION OF SINKS

- A. Comply with installation requirements in SEFA 2.3.
- B. Underside Installation of Epoxy Sinks: Use laboratory casework manufacturer's recommended adjustable support system for table- and cabinet-type installations. Set top edge of sink unit in sink and countertop manufacturers' recommended chemical-resistant sealing compound or adhesive and firmly secure to produce a tight and fully leakproof joint. Adjust sink and securely support to prevent movement. Remove excess sealant or adhesive while still wet and finish joint for neat appearance.

3.5 INSTALLATION OF LABORATORY ACCESSORIES

- A. Install accessories according to Shop Drawings, installation requirements in SEFA 2.3, and manufacturer's written instructions.
- B. Securely fasten adjustable shelving supports, stainless-steel shelves, and pegboards to partition framing, wood blocking, or reinforcements in partitions.
- C. Install shelf standards plumb and at heights to align shelf brackets for level shelves. Install shelving level and straight, closely fitted to other work where indicated.
- D. Securely fasten pegboards to partition framing, wood blocking, or reinforcements in partitions.

3.6 INSTALLATION OF SERVICE FITTINGS

- A. Comply with requirements in Divisions 22 and 26 Sections for installing water and laboratory gas service fittings and electrical devices.
- B. Install fittings according to Shop Drawings, installation requirements in SEFA 2.3, and manufacturer's written instructions. Set bases and flanges of sink- and countertop-mounted fittings in sealant recommended by manufacturer of sink or countertop material. Securely anchor fittings to laboratory casework unless otherwise indicated.

3.7 CLEANING AND PROTECTING

- A. Clean finished surfaces, touch up as required, and remove or refinish damaged or soiled areas to match original factory finish, as approved by Design Professional.
- B. Protect countertop surfaces during construction with 6-mil plastic or other suitable water-resistant covering. Tape to underside of countertop at a minimum of 48 inches o.c.

3.8 SERVICE-FITTING SCHEDULE

- A. Water Service Fitting:
 - 1. Type of Fitting: Rigid, gooseneck mixing faucet.
 - 2. Outlet: Vacuum breaker and removable serrated outlet.
 - 3. Mounting: Deck mounted.
 - 4. Additional Requirements: Wrist blade handles.

END OF SECTION 123553

SECTION 130010

FIBERGLASS CHEMICAL PUMP ENCLOSURE

PART ONE: GENERAL INFORMATION

- 1.01 Furnish one (1) fiberglass composite insulated enclosure that measures 72 inches in length by 72 inches in width and 84 1/2 inches in height.
- 1.02 Specification section that may relate to this work:
 - A. Section 033000 – Cast in Place Concrete
 - B. Section 463300 – Chemical Feed Systems
- 1.03 References and related standards:
 - A. ANSI/AWWA F101 - Contact molded, Fiberglass-Reinforced Plastic Wash Water Troughs
 - B. ASTM D 256 - Standard Test Method for Determining Pendulum Impact Resistance of Notched Specimens of Plastic
 - C. ASTM D 638 - Standard Test Method for Determining Tensile Properties of Plastic
 - D. ASTM D 790 - Standard Test Method for Determining Flexural Properties of Plastic
 - E. ASTM D 2583 - Standard Test Method for Determining the Surface Hardness of Plastic using a Barcol Instrument.
 - F. ASTM D 648 - Standard Test Method for Determining the Distortion of Plastic under controlled Exposure to Elevated Temperatures.
- 1.04 Typical Product Performance Design:
 - A. The structure will be designed for 130 mph wind load when correctly installed.
 - B. The unit is designed to handle live roof loads of 50 pounds per square foot.
- 1.05 Submittals:
 - A. Comply with general conditions of the project documents.
 - B. Product data to include:
 - I. Type, Product Name and Resin Manufacturer
 - II. Test results of fiberglass laminate used
 - C. Shop Drawing showing all critical dimensions of Enclosure.
 - D. Shop Drawing showing location and plan of all Enclosure options.
 - E. Complete off loading, storage, and installation instructions
- 1.06 Delivery, Off Loading and Storage
 - A. Off load structure according to manufacturer's instructions
 - B. Inspect structure completely and report any damage during shipping.
 - C. Store structure on level, firm ground or platform and protect from construction

traffic and damage.

PART TWO: PRODUCT

2.01 Products:

- A. Provide ENDURO Model 600 as manufactured by Virtual Polymer Compounds, or engineer approved equal.
- B. Substitution requests must include evidence that the product meets all standards submitted herein, that the manufacturer has ten years of experience fabricating the product, and there is a complete quality assurance program in place.

2.02 Material of Construction:

- A. Gel Coat: All exposed surfaces will be smooth with a 20-mil polyester-based gel coat. Color of the gel coat is beige.
- B. Structural laminate will be nominal 1 1/2 inch thick. The laminate will include 1/4 inch glass fiber reinforced laminate under 20 mils of gel coat, 1 inch of 1.9 pound density urethane foam insulation and an interior laminate of 1/4 inch glass fiber reinforced laminate.
- C. The resin will meet the following standards:
 - 1. Tensile Strength: ASTM D 638 14,000 psi
 - 2. Flexural Strength: ASTM D 790 25,000 psi
 - 3. Flexural Modulus: ASTM D 790 1,000,000 psi
 - 4. Impact, Notched: ASTM D 256 10 ft-lbs/1
 - 5. Barcol Hardness: ASTM D 2583 40
 - 6. High Temperature Limit: 150°F
 - 7. Chemical Resistance ANSI/AWWAF10
Type II

2.03 Method of Construction: Single piece contact molded fiberglass reinforced plastic with integral 1.9-pound density foam insulation core.

2.04 Metallic mounting hardware is to be 304 grade stainless steel.

2.05 The Enclosure is to include the following standard options:

- A. Fiberglass insulated, gasketed door with opening of 50.75 inches wide by 65 inches tall.
- B. Door hardware is to include three 3 inch by 3 inch stainless steel hinges and three point latch with keyed lockable handle.
- C. Provide one screened, fixed louver vent cover over three vent openings at both the right and left side of the unit. The vents will be located at the top center of the wall.
- D. The unit will be fabricated with an integral fiberglass floor that is 3/8 inch thick with

slip resistant gray finish. The floor will be integral to the wall sections to provide full spill containment.

- E. 1-inch Polyurethane insulation core (R=7)
- F. Continuous 4-inch-wide fiberglass exterior mounting flange with the same finish as the balance of the unit.
- G. 110 Volt, 60-Watt incandescent light with switch mounted on the left sidewall near the door handle.
- H. Ventilation Fan (110 Volt, 60 CFM) with remote thermostat.
- I. Base Board, 110 Volt, 500-Watt electric heater with integral thermostat.
- J. 110 Volt, 20 amp GFI protected Duplex Outlet standard 15 amp duplex
- K. All wire will be run through 1/2 flexible sealed PVC flexible conduit.
- L. All wiring will be completed with #12 solid copper.
- M. 12 in x 12 in window in door.

PART THREE: EXECUTION

- 3.01 Carefully remove structure from original crating only at the time of installation. Examine the unit completely and report any damage to the unit prior to installation.
- 3.02 Verify that the dimensions of the concrete slab (*foundation*) designated for installation are correct and suitable for installation. Report any anticipated problems at once.
- 3.03 Installation:
 - A. Install according to installation instructions provided by the manufacturer.
 - B. Ensure the structure is set plum, true, and level.
 - C. Fasten to foundation using specified fasteners at specified spacing.
 - D. Connect to power from protected circuit.

END OF SECTION

SECTION 220000 - GENERAL PLUMBING PROVISIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.

1.2 SUMMARY

- A. Section includes general provisions covering the contract documents for Plumbing Systems.

1.3 DEFINITIONS

- A. Provide shall mean "Furnish, install and connect."
- B. Piping shall mean "pipe installed with all specified fittings, valves and accessories, and forming a complete system."

1.4 INFORMATIONAL SUBMITTALS

- A. Electrical Coordination Drawings: In addition to submittal requirements of other Division 22, submit a document approved by the project Electrical Contractor certifying that all plumbing equipment being furnished under Division 22 complies with the electrical characteristics of the source power which will be furnished under Division 26.
- B. Model numbers listed on the Plumbing Contract Documents shall not be construed to indicate electrical characteristics. Electrical characteristics of plumbing equipment shall be as indicated on the Electrical Contract Documents. It shall be the Contractor responsibility to coordinate electrical characteristics with electrical contract documents.
- C. Review of Submittals does not relieve the Contractor of any of the requirements of the Contract Documents. Failure by the Engineer to document errors and omissions in the Contractor's submittals during the Engineer's submittal review ***does not*** constitute a waiver of any of the requirements of the original Contract Documents.

1.5 CLOSEOUT SUBMITTALS

- A. Installation Instructions: Two binders containing manufacturer's installation instructions for all equipment furnished under Division 22 shall be furnished by the Contractor. One binder shall be kept in the General Contractor's office at the job site. The other binder shall be delivered to the Engineer upon acceptance by the Architect of the Submittals.

- B. Operation and Maintenance Instructions: Three copies of equipment O&M manuals contained in rigid 3-ring binders shall be submitted to the Owner a minimum of 15 days prior to equipment/systems training. Binders shall have permanent labels on the spine and front cover indicating project name, project number, building name and contents. Model and serial numbers of equipment shall be shown on the cover of their respective O&M manual(s).

1.6 QUALITY ASSURANCE

A. Plumbing Installer Qualifications:

1. Plumbing Subcontractor shall have demonstrated proficiency in the installation of plumbing systems by the successful installation of systems similar to those included in the Construction Documents for this project. Such systems shall have been installed in commercial or institutional buildings having a minimum of 150 plumbing fixtures (in a single building). The Subcontractor shall have been in business as described above for a minimum period of five years.
2. A master or journeyman plumber shall be present at the site during the installation of all plumbing related work. The master or journeyman plumber shall be certified in the state in which the construction is being performed and shall have his license present at site or on file during construction.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Material storage

1. All materials and equipment stored on the jobsite shall be elevated above the ground and stored under suitable weather cover. Materials and equipment shall not be stored in areas subjected to localized flooding.
2. Manufacturer's original shipping packaging and protective coverings shall be left in place until the equipment is prepared for installation.

B. Electrical enclosure protection

1. During construction, all protective covers and other devices shall be left in place that protect against inadvertent contact with live electrical circuits.
2. All warning labels related to electrical and rotating equipment hazards shall be in place prior to energizing plumbing equipment circuits.

C. Protection of piping

1. Maintain temporary closures on the ends of all piping as the installation work progresses. Temporary closures include plastic sheeting, tape and appropriate caps and covers.
2. Where debris enters piping during installation, steps shall be taken to clean the interior of the pipe prior to placing in service.

- D. Roof protection: All penetrations through roofs, including roof curbs, piping curbs and roof drainage system elements shall be properly protected during construction to prevent water

intrusion into the building. Protective measures could include temporary covers and plugs, as well as other appropriate temporary elements.

1.8 PRIOR APPROVALS

- A. Manufacturers References: When reference is made in the Contract Documents to trade names or specific manufacturers and/or models, such reference, unless noted otherwise, is made to designate and identify the quality of materials or equipment to be furnished and is not intended to restrict competitive bidding. If it is desired to use materials or equipment different from those indicated on the Contract Documents, written request for approval ***must*** be received by the Architect at least TEN DAYS prior to the date set for the opening of bids. A copy of the request should also be sent directly to the Engineer. Requests for prior approval of a proposed substitute shall be accompanied by complete technical data supporting the request. ***Request after the TEN DAY prior approval shall be automatically rejected.***
- B. Request for Prior Approval by facsimile transmission (fax) will ***not*** be considered. Prior approval requests shall be submitted in hard copy or email format only.

1.9 PERMITS AND FEES

- A. Obtain all necessary Permits and Inspections required for the installation of this work and pay all charges incident thereto. Deliver to the Architect all certificates of inspection issued by authorities having jurisdiction.
- B. Sewer tap fees, water tap fees, meter fees, Dept. of Labor Fees for Boilers and Pressure Vessels and all other charges for work under Division 22, including charges for meter installation and excess service by the Gas Company or any other utilities shall be paid by the Contractor.

1.10 SAFETY

- A. OSHA Requirements applicable to the project shall be complied with at all times.
- B. Manufacturer's Safety Instructions shall be followed in all instances.
- C. Asbestos Containing Materials (ACM) shall not be used on this project.
- D. Guards shall be provided where appliances, equipment, fans or other components that require service are located within 10 feet of a roof edge or open side of a walking surface and such edge or open side is located more than 30 inches above the floor, roof or grade below. The guard shall extend not less than 30 inches beyond each end of such appliances, equipment, fans, components and roof hatch openings and the top of the guard shall be located not less than 42 inches above the elevated surface adjacent to the guard. The guard shall be constructed so as to prevent the passage of a 21 inch diameter sphere and shall comply with the loading requirements for guards specified in the International Building Code.

1.11 FIELD CONDITIONS

- A. Electrical Equipment Clearances: Piping, equipment and other plumbing installations shall not be located within 42" of the front or 36" of the side of any electrical switchboards, panelboards, power panels, motor control centers, electrical transformers or similar electrical equipment. Piping and ductwork shall not pass through or above electrical equipment rooms except as required to serve those rooms.
- B. Layout:
 - 1. The equipment listed on the Drawings is considered basis of design equipment and has been used for the physical arrangement of the plumbing systems. When other equipment listed in the specifications as acceptable, equal or equipment which has received "prior approval" is used, it shall be the Contractor's responsibility to provide structural, ductwork, electrical, service clearances, or other changes required to accommodate the substituted equipment. Changes to use non basis of design equipment shall be made at no additional cost to the Owner. Submit a list of required changes along with all prior approval requests and shop drawing submittals.
 - 2. The Contract Drawings are intended to show the general arrangement of all plumbing work. They do not show in detail all offsets, fittings and transitions. Examine Drawings, investigate site conditions to be encountered and arrange work accordingly. Furnish all offsets and transitions required for a complete and functional installation.
 - 3. Drawings do not indicate in detail exact configuration of connections for fixtures, equipment and accessories. Final connection shall be as shown on approved Manufacturer's Submittal Drawings. Where Manufacturer's Submittal Drawings conflict with the Contract Documents, consult with the Architect for resolution.
- C. Measurement of Drawings by scale shall not be used as dimensions for fabrication. Measurements for locating fixtures, equipment, ductwork, piping and other plumbing items shall be made on the site and shall be based on actual job site conditions.
- D. Check spatial limitations and verify electrical requirements before ordering any plumbing equipment or materials. Before ordering materials or fabricating ductwork and piping, notify Architect if conflicts are detected with other building components. Place large equipment inside the building prior to the erection of exterior walls where equipment cannot enter finished building openings.
- E. Coordination: Plumbing work shall be coordinated with that of other trades to avoid conflict. The Contractor shall study all plans and specifications for this project and shall notify the Architect of any conflict between work under Division 22, and work under other divisions of the Project. Particular attention shall be given to interference between piping, electrical installations, structural systems, building openings and ductwork.
- F. Failure to accurately and timely coordinate with other trades for installation of plumbing systems shall not result in additional charges to the owner, architect or engineer.

1.12 CODES AND STANDARDS

- A. Plumbing installations shall conform to the latest edition or the addition approved by the authority having jurisdiction of the following, in addition to any other mentioned Codes and Standards.

1. The International Building Code.
2. The International Mechanical Code.
3. The International Plumbing Code
4. The State Energy Code
5. The International Fire Protection Code
6. NFPA Standard 13, Installation of Sprinkler Systems.
7. NFPA Standard 70, National Electric Code.
8. NFPA Standard 90A, Installation of Air Conditioning and Ventilation Systems.
9. NFPA Standard 101, Code for Safety to Life for Fire in Buildings and Structures.

1.13 INTERRUPTION OF EXISTING SERVICES

- A. Exercise care so as not to cut any existing utilities or services. Where an existing utility line or service line is cut it shall be repaired to "like-new" condition. Interruption of service shall not be made without prior written permission of the Owner.
- B. Plumbing systems must remain in service during construction. Arrange with the Owner well in advance of shutdowns required for tie-ins. Shutdowns shall be made after normal occupancy hours if so directed by the Owner. No additional monies will be paid for after-hours shutdowns.

PART 2 - PRODUCTS (Not applicable for this section.)

PART 3 - EXECUTION (Not applicable for this section.)

END OF SECTION 220000

SECTION 220500 - BASIC PLUMBING MATERIALS AND METHODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.

1.2 SUMMARY

- A. Section includes the following basic plumbing materials and methods to complement other plumbing sections..
 1. Non-shrink grout for equipment installations.
 2. Fire stopping.
 3. Installation requirements common to equipment specification sections.
 4. Touchup painting and finishing.
 5. Concrete equipment base construction requirements.
 6. Demolition.
 7. Cutting and Patching.
- B. See individual piping sections for pipe and pipe fitting materials.

1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than plumbing and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

1.4 SUBMITTALS

- A. General: Submit the following according to the Conditions of the Contract.
- B. Prepare coordination drawings of Mechanical Rooms to a 1/4 inch equals 1 foot scale or larger. Detail major elements, components, and systems of plumbing equipment and materials in relationship with other systems, installations, and building components. Show space requirements for installation and access. Show where sequence and coordination of installations are important to the efficient flow of the Work. Include the following:
 - 1. Proposed locations of piping, ductwork, equipment, and materials. Include the following:
 - a. Planned piping layout, including valve and specialty locations and valve stem movement.
 - b. Planned duct systems layout, including elbow radii and duct accessories.
 - c. Clearances for installing and maintaining insulation.
 - d. Clearances for servicing and maintaining equipment, including space for equipment disassembly required for periodic maintenance.
 - e. Equipment service connections and support details.
 - f. Exterior wall and foundation penetrations.
 - g. Fire-rated wall and floor penetrations.
 - h. Sizes and location of required concrete pads and bases.
 - 2. Scheduling, sequencing, movement, and positioning of large equipment into the building during construction.
 - 3. Floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.
 - 4. Reflected ceiling plans to coordinate and integrate installations, air outlets and inlets, light fixtures, communication systems components, sprinklers, and other ceiling-mounted items.

1.5 QUALITY ASSURANCE

- A. Equipment Selection: Equipment of greater or larger power, dimensions, capacities, and ratings may be furnished provided such proposed equipment is approved in writing and connecting plumbing and electrical services, circuit breakers, conduit, motors, bases, and equipment spaces are increased. No additional costs will be approved for these increases, if larger equipment is approved. If minimum energy ratings or efficiencies of the equipment are specified, the equipment must meet the design requirements and commissioning requirements.
- B. Coordinate all electrical service requirements for plumbing equipment prior to the submittal of shop drawings. Confirm the compatibility of all power services with the equipment being furnished. Confirm compatibility of electrical lugs being provided by the equipment manufacturer with the power wiring being furnished under Division 26. Furnish written documentation that all characteristics have been coordinated with and confirmed by the electrical subcontractor.

1.6 SEQUENCING AND SCHEDULING

- A. Coordinate plumbing equipment installation with other building components.

- B. Arrange for chases, slots, and openings in building structure during progress of construction to allow for plumbing installations.
- C. Coordinate the installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
- D. Sequence, coordinate, and integrate installations of plumbing materials and equipment for efficient flow of the Work. Coordinate installation of large equipment requiring positioning prior to closing in the building.
- E. Coordinate connection of electrical services.
- F. Coordinate connection of plumbing systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies.
- G. Coordinate requirements for access panels and doors where plumbing items requiring access are concealed behind finished surfaces.
- H. Coordinate installation of identifying devices after completing covering and painting where devices are applied to surfaces. Install identifying devices prior to installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 GROUT

- A. Nonshrink, Nonmetallic Grout: ASTM C 1107, Grade B.
 - 1. Characteristics: Post-hardening, volume-adjusting, dry, hydraulic-cement grout, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.
 - 3. Packaging: Premixed and factory-packaged.

2.2 FIRE STOPPING

- A. Fire-Resistant Sealant: Provide UL Listed firestopping system for filling openings around penetrations through walls and floors, having fire-resistance ratings indicated as established by testing identical assemblies per ASTM E 814 by Underwriters Laboratory, Inc. or other testing and inspecting agency acceptable to authorities having jurisdiction.
- B. Products: Subject to compliance with requirements, provide products by one of the following:
 - 1. Dow Corning Corp.
 - 2. 3M Corporation
 - 3. General Electric Co.
 - 4. Standard Oil Engineered Materials Co.

5. Hilti, Inc.
6. Tremco Corp.

PART 3 - EXECUTION

3.1 GROUTING

- A. Install nonmetallic nonshrink grout for plumbing equipment base bearing surfaces, pump and other equipment base plates, and anchors. Mix grout according to manufacturer's printed instructions.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms for placement of grout, as required.
- D. Avoid air entrapment when placing grout.
- E. Place grout to completely fill equipment bases.
- F. Place grout on concrete bases to provide a smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout according to manufacturer's printed instructions.

3.2 FIRESTOPPING

- A. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials

3.3 COMMON INSTALLATION REQUIREMENTS

- A. General Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate general location and arrangement of plumbing systems. Indicated locations and arrangements were used to size ductwork and pipe; and calculate friction loss, expansion, pump sizing, and other design considerations. Install ductwork and piping as indicated, except where deviations to layout are approved on coordination drawings.
- B. Install equipment to provide the maximum possible headroom where mounting heights are not indicated.
- C. Install equipment according to approved submittal data. Portions of the Work are shown only in diagrammatic form. Refer conflicts to the Architect.
- D. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, except where otherwise indicated.

- E. Install plumbing equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. Connect equipment for ease of disconnecting, with minimum of interference with other installations. Extend grease fittings to an accessible location.
- F. Install equipment giving right-of-way to piping systems installed at a required slope.

3.4 PAINTING AND FINISHING

- A. Damage and Touch Up: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.
- B. Paint all exposed steel surfaces of piping and supports with one coat of primer and two coats of enamel.

3.5 CONCRETE BASES

- A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
 1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
 3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
 4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 5. Install anchor bolts to elevations required for proper attachment to supported equipment.
 6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
 7. Use 3000-psi, 28-day compressive strength concrete with 6 x 6 x #10 reinforcing wire mesh.
 8. Outdoor concrete bases shall extend a minimum of 4" above grade and be a minimum thickness of 6".

END OF SECTION 220500

SECTION 220517 - SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 1. Sleeves.
 2. Stack-sleeve fittings.
 3. Sleeve-seal systems.
 4. Sleeve-seal fittings.
 5. Grout.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.1 SLEEVES

- A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral water stop unless otherwise indicated.
- B. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.
- C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.
- D. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.
- E. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- F. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.

2.2 STACK-SLEEVE FITTINGS

- A. Description: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring, bolts, and nuts for membrane flashing.
 1. Underdeck Clamp: Clamping ring with setscrews.

2.3 SLEEVE-SEAL SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Advance Products & Systems, Inc.
 - 2. CALPICO, Inc.
 - 3. Metraflex Company (The).
 - 4. Pipeline Seal and Insulator, Inc.
 - 5. Proco Products, Inc.
- B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
 - 1. Sealing Elements: NBR interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.

2.4 SLEEVE-SEAL FITTINGS

- A. Description: Manufactured plastic, sleeve-type, water stop assembly made for imbedding in concrete slab or wall. Unit has plastic or rubber water stop collar with center opening to match piping OD.

2.5 GROUT

- A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Non-shrink; recommended for interior and exterior applications.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.
 - 1. Sleeves are not required for core-drilled holes.
- C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
 - 1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.

2. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.
 3. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.
- D. Install sleeves for pipes passing through interior partitions.
1. Cut sleeves to length for mounting flush with both surfaces.
 2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
 3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Section "Joint Sealants."
- E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section "Penetration Firestopping."

3.2 STACK-SLEEVE-FITTING INSTALLATION

- A. Install stack-sleeve fittings in new slabs as slabs are constructed.
1. Install fittings that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
 2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Section "Sheet Metal Flashing and Trim."
 3. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level.
 4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
 5. Using grout, seal the space around outside of stack-sleeve fittings.
- B. Fire-Barrier Penetrations: Maintain indicated fire rating of floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section "Penetration Firestopping."

3.3 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.
- B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.4 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position water stop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Using grout, seal the space around outside of sleeve-seal fittings.

3.5 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. NOTE: PVC PIPING NOT ALLOWED IN RETURN AIR PLENUMS

- 1. Exterior Concrete Walls below Grade:
 - a. Cast-iron wall sleeves or Schedule 40 PVC pipe sleeves. **Foam core not allowed.**
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
- 2. Concrete Slabs-on-Grade:
 - a. Cast-iron wall sleeves with sleeve-seal system or Schedule 40 PVC pipe sleeves. **Foam core not allowed.**
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
- 3. Concrete Slabs above Grade:
 - a. Piping Smaller Than NPS 6: [Galvanized-steel-pipe sleeves] or Schedule 40 PVC pipe sleeves. **Foam core not allowed.**
- 4. Interior Partitions:
 - a. . Foam core not allowed.

END OF SECTION 220517

SECTION 220518 - ESCUTCHEONS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Escutcheons.
 - 2. Floor plates.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

- A. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.
- C. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.
- D. Split-Casting Brass Type: With polished, chrome-plated finish and with concealed hinge and setscrew.
- E. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed hinge, and spring-clip fasteners.

2.2 FLOOR PLATES

- A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.
- B. Split-Casting Floor Plates: Cast brass with concealed hinge.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
- B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of insulated piping and with OD that completely covers opening.
 - 1. Escutcheons for New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - b. Chrome-Plated Piping: One-piece, split-casting brass type with polished, chrome-plated finish.
 - c. Insulated Piping: split-plate, stamped-steel type with concealed hinge.
 - d. Bare Piping in Finished and Unfinished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
 - 2. Escutcheons for Existing Piping:
 - a. Chrome-Plated Piping: Split-casting brass type with polished, chrome-plated finish.
 - b. Insulated Piping: Split-plate, stamped-steel type with concealed hinge.
 - c. Bare Piping in Finished and Unfinished Spaces: Split-casting brass type with polished, chrome-plated finish.
- C. Install floor plates for piping penetrations of equipment-room floors.
- D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
 - 1. New Piping: One-piece, floor-plate type.
 - 2. Existing Piping: Split-casting, floor-plate type.

3.2 FIELD QUALITY CONTROL

- A. Replace broken and damaged escutcheons and floor plates using new materials.

END OF SECTION 220518

SECTION 220523.14 - CHECK VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Bronze lift check valves.
 - 2. Bronze swing check valves.
 - 3. Iron swing check valves.
 - 4. Iron swing check valves with closure control.
 - 5. Iron, grooved-end swing check valves.
 - 6. Iron, center-guided check valves.
 - 7. Iron, plate-type check valves.

1.3 DEFINITIONS

- A. CWP: Cold working pressure.
- B. EPDM: Ethylene propylene-diene terpolymer rubber.
- C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of valve.
 - 1. Certification that products comply with NSF 6161 Annex G and NSF 372.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Protect internal parts against rust and corrosion.
 - 2. Protect threads, flange faces, grooves, and weld ends.
 - 3. Set check valves in either closed or open position.
- B. Use the following precautions during storage:

1. Maintain valve end protection.
 2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. ASME Compliance:
1. ASME B1.20.1 for threads for threaded end valves.
 2. ASME B16.1 for flanges on iron valves.
 3. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
 4. ASME B16.18 for solder joint.
 5. ASME B31.9 for building services piping valves.
- C. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.
- D. NSF Compliance: NSF 61]for valve materials for potable-water service.
- E. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.
- F. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- G. Valve Sizes: Same as upstream piping unless otherwise indicated.
- H. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRONZE LIFT CHECK VALVES

- A. Class 125, Lift Check Valves with Bronze Disc:
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Crane Co.; Crane Valve Group; Jenkins Valves.
 - c. Crane Co.; Crane Valve Group; Stockham Valves.
 2. Description:

- a. Standard: MSS SP-80, Type 1.
- b. CWP Rating: 200 psig.
- c. Body Design: Vertical flow.
- d. Body Material: ASTM B 61 or ASTM B 62, bronze.
- e. Ends: Threaded or soldered. See valve schedule articles.
- f. Disc: Bronze.

2.3 BRONZE SWING CHECK VALVES

A. Class 150, Bronze Swing Check Valves with Bronze Disc:

- 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. American Valve, Inc.
 - b. Crane Co.; Crane Valve Group; Crane Valves.
 - c. Crane Co.; Crane Valve Group; Jenkins Valves.
 - d. Crane Co.; Crane Valve Group; Stockham Valves.
 - e. Kitz Corporation.
 - f. The Macomb Groups.
 - g. Milwaukee Valve Company.
 - h. NIBCO INC.
- 2. Description:
 - a. Standard: MSS SP-80, Type 3.
 - b. CWP Rating: 300 psig.
 - c. Body Design: Horizontal flow.
 - d. Body Material: ASTM B 62, bronze.
 - e. Ends: Threaded or soldered. See valve schedule articles.
 - f. Disc: Bronze.
 - g. .

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.

- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.
- E. Install check valves for proper direction of flow and as follows:
 - 1. Swing Check Valves: In horizontal position with hinge pin level.
 - 2. Center-Guided] Check Valves: In horizontal or vertical position, between flanges.
 - 3. Lift Check Valves: With stem upright and plumb.
- F. Install valve tags. Comply with requirements in Section "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

3.3 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valve applications are not indicated, use the following:
 - 1. Pump-Discharge Check Valves:
 - a. NPS 2 and Smaller: Bronze swing check valves with bronze disc.
- B. If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.
- C. End Connections:
 - 1. For Copper Tubing, NPS 2 and Smaller: Threaded or soldered.
 - 2. For Grooved-End Copper Tubing]: Grooved.

3.5 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

- A. Pipe NPS 2 and Smaller: Bronze swing check valves, Class 150, bronze disc with threaded end connections.

END OF SECTION 220523.14

SECTION 220523.15 - GATE VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Bronze gate valves.

1.3 DEFINITIONS

- A. CWP: Cold working pressure.
- B. NRS: Nonrising stem.
- C. RS: Rising stem.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of valve.
 - 1. Certification that products comply with NSF 61.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Protect internal parts against rust and corrosion.
 - 2. Protect threads, flange faces, grooves, and weld ends.
 - 3. Set gate valves closed to prevent rattling.
- B. Use the following precautions during storage:
 - 1. Maintain valve end protection.
 - 2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. ASME Compliance:
 - 1. ASME B1.20.1 for threads for threaded end valves.
 - 2. ASME B16.1 for flanges on iron valves.
 - 3. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
 - 4. ASME B16.18 for solder joint.
 - 5. ASME B31.9 for building services piping valves.
- C. NSF Compliance: NSF 61 for valve materials for potable-water service.
- D. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.
- E. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- F. Valve Sizes: Same as upstream piping unless otherwise indicated.
- G. RS Valves in Insulated Piping: With 2-inch stem extensions.
- H. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRONZE GATE VALVES

- A. Class 125, NRS, Bronze Gate Valves:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. American Valve, Inc.
 - b. Crane Co.; Crane Valve Group; Crane Valves.
 - c. Crane Co.; Crane Valve Group; Jenkins Valves.
 - d. Crane Co.; Crane Valve Group; Stockham Valves.
 - e. Hammond Valve.
 - f. Kitz Corporation.
 - g. The Macomb Groups.
 - h. Milwaukee Valve Company.
 - i. NIBCO INC.
 - j. Powell Valves.
 - k. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - 2. Description:

- a. Standard: MSS SP-80, Type 1.
- b. CWP Rating: 200 psig.
- c. Body Material: Bronze with integral seat and screw-in bonnet.
- d. Ends: Threaded or solder joint.
- e. Stem: Bronze.
- f. Disc: Solid wedge; bronze.
- g. Packing: Asbestos free.
- h. Handwheel: Malleable iron, bronze, or aluminum.

B. Class 125, RS, Bronze Gate Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

- a. American Valve, Inc.
- b. Crane Co.; Crane Valve Group; Crane Valves.
- c. Crane Co.; Crane Valve Group; Jenkins Valves.
- d. Crane Co.; Crane Valve Group; Stockham Valves.
- e. Hammond Valve.
- f. Kitz Corporation.
- g. The Macomb Groups.
- h. Milwaukee Valve Company.
- i. NIBCO INC.
- j. Powell Valves.
- k. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

- a. Standard: MSS SP-80, Type 2.
- b. CWP Rating: 200 psig.
- c. Body Material: Bronze with integral seat and screw-in bonnet.
- d. Ends: Threaded or solder joint.
- e. Stem: Bronze.
- f. Disc: Solid wedge; bronze.
- g. Packing: Asbestos free.
- h. Handwheel: Malleable iron, bronze, or aluminum.

C. Class 150, RS, Bronze Gate Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

- a. Crane Co.; Crane Valve Group; Crane Valves.
- b. Crane Co.; Crane Valve Group; Stockham Valves.
- c. Hammond Valve.
- d. Kitz Corporation.
- e. The Macomb Groups.
- f. Milwaukee Valve Company.
- g. NIBCO INC.
- h. Powell Valves.
- i. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

- a. Standard: MSS SP-80, Type 2.
- b. CWP Rating: 300 psig.
- c. Body Material: Bronze with integral seat and union-ring bonnet.
- d. Ends: Threaded.
- e. Stem: Bronze.
- f. Disc: Solid wedge; bronze.
- g. Packing: Asbestos free.
- h. Handwheel: Malleable iron, bronze, or aluminum.

2.3 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.

2.4 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.
- E. Install chainwheels on operators for gate valves NPS 4 and larger and more than 96 inches above floor. Extend chains to 60 inches above finished floor.
- F. Install valve tags. Comply with requirements in Section "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

2.5 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

2.6 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. Use gate valves for shutoff service only.
- B. If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.
- C. For Grooved-End Copper Tubing: Valve ends may be grooved.

2.7 LOW-PRESSURE, COMPRESSED-AIR VALVE SCHEDULE (150 PSIG OR LESS)

- A. Pipe NPS 2 and Smaller: Bronze gate valves, Class 150, NRS with threaded ends.
- B. Pipe NPS 2-1/2 and Larger: Iron gate valves, Class 250, NRS with flanged ends.

2.8 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

- A. Pipe NPS 2 and Smaller: Bronze gate valves, Class 125, NRS with threaded ends.
- B. Pipe NPS 2-1/2 and Larger: Iron gate valves, Class 125, OS&Y with flanged ends.

END OF SECTION 220523.15

SECTION 220529 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Metal pipe hangers and supports.
 - 2. Trapeze pipe hangers.
 - 3. Metal framing systems.
 - 4. Thermal-hanger shield inserts.
 - 5. Fastener systems.
 - 6. Pipe stands.
 - 7. Pipe positioning systems.
 - 8. Equipment supports.

1.3 DEFINITIONS

- A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings Show fabrication and installation details and include calculations for the following; include Product Data for components:
 - 1. Trapeze pipe hangers.
 - 2. Metal framing systems.
 - 3. Pipe stands.
 - 4. Equipment supports.
- C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - 1. Detail fabrication and assembly of trapeze hangers.
 - 2. Design Calculations: Calculate requirements for designing trapeze hangers.

1.5 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.6 QUALITY ASSURANCE

- A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

- A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

2.2 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.3 METAL FRAMING SYSTEMS

- A. MFMA Manufacturer Metal Framing Systems:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allied Tube & Conduit.
 - b. Cooper B-Line, Inc.
 - c. Flex-Strut Inc.
 - d. GS Metals Corp.
 - e. Thomas & Betts Corporation.
 - f. Unistrut Corporation; Tyco International, Ltd.
 - g. Wesanco, Inc.

2. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
3. Standard: MFMA-4.
4. Channels: Continuous slotted steel channel with inturned lips.
5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
7. Metallic Coating: Galvanized or alternate rust preventing shop coating. Paint coating with two coats primer and one coat enamel.

B. Non-MFMA Manufacturer Metal Framing Systems:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Anvil International; a subsidiary of Mueller Water Products Inc.
 - b. Empire Industries, Inc.
 - c. ERICO International Corporation.
 - d. Haydon Corporation; H-Strut Division.
 - e. NIBCO INC.
 - f. PHD Manufacturing, Inc.
 - g. PHS Industries, Inc.
2. Description: Shop- or field-fabricated pipe-support assembly made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
3. Standard: Comply with MFMA-4.
4. Channels: Continuous slotted steel channel with inturned lips.
5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
7. Coating: galvanized or alternate rust preventing shop coating.

2.4 THERMAL-HANGER SHIELD INSERTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Carpenter & Paterson, Inc.
2. Clement Support Services.
3. ERICO International Corporation.
4. National Pipe Hanger Corporation.
5. PHS Industries, Inc.
6. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
7. Piping Technology & Products, Inc.
8. Rilco Manufacturing Co., Inc.
9. Value Engineered Products, Inc.

B. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.

- C. Insulation-Insert Material for Hot Piping: Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength.
- D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- F. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.5 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
- B. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.6 PIPE STANDS

- A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.
- B. Compact Pipe Stand: One-piece plastic unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.
- C. Low-Type, Single-Pipe Stand: One-piece plastic or stainless-steel base unit with plastic roller, for roof installation without membrane penetration.
- D. High-Type, Single-Pipe Stand:
 1. Description: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
 2. Base: Plastic.
 3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
 4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.
- E. High-Type, Multiple-Pipe Stand:
 1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
 2. Bases: One or more; plastic.
 3. Vertical Members: Two or more protective-coated-steel channels.
 4. Horizontal Member: Protective-coated-steel channel.
 5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.

- F. Curb-Mounting-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

2.7 PIPE POSITIONING SYSTEMS

- A. Description: IAPMO PS 42, positioning system of metal brackets, clips, and straps for positioning piping in pipe spaces; for plumbing fixtures in commercial applications.

2.8 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.9 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.
- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
 - 1. Properties: Nonstaining, noncorrosive, and nongaseous.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
 - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
 - 2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.
- D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

- E. Fastener System Installation:
 - 1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
 - 2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- F. Pipe Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture.
- G. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- H. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- I. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- J. Install lateral bracing with pipe hangers and supports to prevent swaying.
- K. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- L. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- M. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- N. Insulated Piping:
 - 1. Attach clamps and spacers to piping.
 - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
 - 2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
4. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
 - b. NPS 4: 12 inches long and 0.06 inch thick.
 - c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
 - d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
 - e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make bearing surface smooth.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 2. Obtain fusion without undercut or overlap.
 3. Remove welding flux immediately.
 4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.5 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.
- B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.6 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use carbon-steel pipe hangers and supports and attachments for general service applications.
- F. Use padded hangers for piping that is subject to scratching.
- G. Use thermal-hanger shield inserts for insulated piping and tubing.
- H. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
 - 2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F, pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
 - 3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.

4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.
7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.
11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.
12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.
19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

I. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

- J. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
 3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
 4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
 5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.
- K. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 6. C-Clamps (MSS Type 23): For structural shapes.
 7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
 10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
 11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb.
 - b. Medium (MSS Type 32): 1500 lb.
 - c. Heavy (MSS Type 33): 3000 lb.
 13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
 15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
- L. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.

3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- M. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
 2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
 3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
 4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
 5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
 6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
 7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
 8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
 - a. Horizontal (MSS Type 54): Mounted horizontally.
 - b. Vertical (MSS Type 55): Mounted vertically.
 - c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.
- N. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- O. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.
- P. Use powder-actuated fasteners] or mechanical-expansion anchors instead of building attachments where required in concrete construction.
- Q. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

END OF SECTION 220529

SECTION 220548 - **VIBRATION AND SEISMIC CONTROLS FOR PLUMBING PIPING AND EQUIPMENT**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

1. Elastomeric isolation pads.
2. Elastomeric isolation mounts.
3. Restrained elastomeric isolation mounts.
4. Open-spring isolators.
5. Housed-spring isolators.
6. Restrained-spring isolators.
7. Housed-restrained-spring isolators.
8. Pipe-riser resilient supports.
9. Resilient pipe guides.
10. Elastomeric hangers.
11. Spring hangers.
12. Snubbers.
13. Restraint channel bracings.
14. Restraint cables.
15. Seismic-restraint accessories.
16. Mechanical anchor bolts.
17. Adhesive anchor bolts.

- B. Related Requirements:

1. Section "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment" for devices for fire-suppression equipment and systems.
2. Section "Vibration and Seismic Controls for HVAC" for devices for HVAC equipment and systems.

1.3 DEFINITIONS

- A. IBC: International Building Code.
- B. ICC-ES: ICC-Evaluation Service.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device and seismic-restraint component required.
 - a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an agency acceptable to authorities having jurisdiction.
 - b. Annotate to indicate application of each product submitted and compliance with requirements.
3. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.

B. Shop Drawings:

1. Detail fabrication and assembly of equipment bases. Detail fabrication including anchorages and attachments to structure and to supported equipment.

C. Delegated-Design Submittal: For each vibration isolation and seismic-restraint device.

1. Include design calculations and details for selecting vibration isolators and seismic restraints complying with performance requirements, design criteria, and analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
2. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, due to seismic forces required to select vibration isolators, and due to seismic restraints.
3. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification that riser system was examined for excessive stress and that none exists.
4. Seismic-Restraint Details:
 - a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
 - b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
 - c. Coordinate seismic-restraint and vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.
 - d. Preapproval and Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Show coordination of vibration isolation device installation and seismic bracing for plumbing piping and equipment with other systems and equipment in the vicinity, including other supports and restraints, if any.
- B. Qualification Data: For professional engineer and testing agency.
- C. Welding certificates.
- D. Field quality-control reports.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7 and that is acceptable to authorities having jurisdiction.
- B. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.
- C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are unavailable, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Seismic-Restraint Loading:
 - 1. Site Class as Defined in the IBC: D.
 - 2. Assigned Seismic Use Group or Building Category as Defined in the IBC: I].
 - a. Component Importance Factor: 1.0].
 - b. Component Response Modification Factor: 1.5].
 - c. Component Amplification Factor: 1.0.
 - 3. Design Spectral Response Acceleration at Short Periods (0.2 Second):
 - 4. Design Spectral Response Acceleration at 1.0-Second Period
 - 5. Rated strengths, features, and applications shall be as defined in reports by an agency acceptable to authorities having jurisdiction.

- a. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least **[four]** times the maximum seismic forces to which they are subjected.

2.2 APPROVED MANUFACTURERS

- A. Provide products as indicated below or on Drawings by one of the manufacturers listed below. The manufacturer shall be an active member of Vibration Isolation and Seismic Control Manufacturers Association (VISCMA).
 1. California Dynamics Corporation.
 2. Kinetics Noise Control, Inc.
 3. Mason Industries, Inc.
 4. Vibration Eliminator Co., Inc.
 5. Vibro-Acoustics
 6. Vibration Isolation
 7. Vibration Mountings & Controls, Inc.

2.3 ELASTOMERIC ISOLATION PADS

- A. Elastomeric Isolation Pads:
 1. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
 2. Size: Factory or field cut to match requirements of supported equipment.
 3. Pad Material: Oil and water resistant with elastomeric properties.
 4. Surface Pattern: Waffle pattern.
 5. Load-bearing metal plates adhered to pads.

2.4 ELASTOMERIC ISOLATION MOUNTS

- A. Double-Deflection, Elastomeric Isolation Mounts:
 1. Mounting Plates:
 - a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded with threaded studs or bolts.
 - b. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.
 2. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.5 RESTRAINED ELASTOMERIC ISOLATION MOUNTS

- A. Restrained Elastomeric Isolation Mounts:
 1. Description: All-directional isolator with seismic restraints containing two separate and opposing elastomeric elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.

- a. Housing: Cast-ductile iron or welded steel.
- b. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.6 OPEN-SPRING ISOLATORS

- A. Freestanding, Laterally Stable, Open-Spring Isolators:
 - 1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 - 2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 - 3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 - 4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 - 5. Baseplates: Factory-drilled steel plate for bolting to structure with an elastomeric isolator pad attached to the underside. Baseplates shall limit floor load to 500 psig.
 - 6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

2.7 HOUSED-SPRING ISOLATORS

- A. Freestanding, Laterally Stable, Open-Spring Isolators in Two-Part Telescoping Housing:
 - 1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 - 2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 - 3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 - 4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 - 5. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators.
 - a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.
 - b. Top housing with threaded mounting holes and internal leveling device.

2.8 RESTRAINED-SPRING ISOLATORS

- A. Freestanding, Laterally Stable, Open-Spring Isolators with Vertical-Limit Stop Restraint:
 - 1. Housing: Steel housing with vertical-limit stops to prevent spring extension due to weight being removed.
 - a. Base with holes for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.
 - b. Top plate with threaded mounting holes.
 - c. Internal leveling bolt that acts as blocking during installation.
 - 2. Restraint: Limit stop as required for equipment and authorities having jurisdiction.
 - 3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.

4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.9 HOUSED-RESTRAINED-SPRING ISOLATORS

1. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators. Housings are equipped with adjustable snubbers to limit vertical movement.
 - a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.
 - b. Threaded top housing with adjustment bolt and cap screw to fasten and level equipment.
2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.10 PIPE-RISER RESILIENT SUPPORT

- A. Description: All-directional, acoustical pipe anchor consisting of two steel tubes separated by a minimum 1/2-inch-thick neoprene.
 1. Vertical-Limit Stops: Steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions.
 2. Maximum Load Per Support: 500 psig on isolation material providing equal isolation in all directions.

2.11 RESILIENT PIPE GUIDES

- A. Description: Telescopic arrangement of two steel tubes or post and sleeve arrangement separated by a minimum 3/8-inch-thick neoprene.
 1. Factory-Set Height Guide with Shear Pin: Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

2.12 ELASTOMERIC HANGERS

- A. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods:
 1. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.

2. Dampening Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel to steel contact.

2.13 SPRING HANGERS

- A. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression:
 1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
 2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 6. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
 7. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
 8. Self-centering hanger-rod cap to ensure concentricity between hanger rod and support spring coil.

2.14 SNUBBERS

- A. Description: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.
 1. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.
 2. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
 3. Maximum 1/4-inch air gap, and minimum 1/4-inch- thick resilient cushion.

2.15 RESTRAINT CHANNEL BRACINGS

- A. Description: MFMA-4, shop- or field-fabricated bracing assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

2.16 RESTRAINT CABLES

- A. Restraint Cables: ASTM A 492 stainless-steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; with a minimum of two clamping bolts for cable engagement.

2.17 SEISMIC-RESTRAINT ACCESSORIES

- A. Hanger-Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod.
- B. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings.
- C. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.
- D. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.
- E. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

2.18 MECHANICAL ANCHOR BOLTS

- A. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

2.19 ADHESIVE ANCHOR BOLTS

- A. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing PVC or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation and seismic-control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

- A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.
- B. Hanger-Rod Stiffeners: Install hanger-rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.
- C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength is adequate to carry present and future static and seismic loads within specified loading limits.

3.3 VIBRATION CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

- A. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.
- B. Comply with requirements in Section "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.
- C. Equipment Restraints:
 - 1. Install seismic snubbers on plumbing equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
 - 2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
 - 3. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction that provides required submittals for component.
- D. Piping Restraints:
 - 1. Comply with requirements in MSS SP-127.
 - 2. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
 - 3. Brace a change of direction longer than 12 feet.
- E. Install cables so they do not bend across edges of adjacent equipment or building structure.
- F. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction that provides required submittals for component.
- G. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.
- H. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
- I. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

J. Drilled-in Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

- A. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Comply with requirements in Section 221116 "Domestic Water Piping" for piping flexible connections.

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: [Engage] a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections.
- C. Tests and Inspections:
1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
 2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
 3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
 4. Test at least **[four]** of each type and size of installed anchors and fasteners selected by Architect.
 5. Test to 90 percent of rated proof load of device.
 6. Measure isolator restraint clearance.
 7. Measure isolator deflection.
 8. Verify snubber minimum clearances.

- D. Remove and replace malfunctioning units and retest as specified above.
- E. Prepare test and inspection reports.

3.6 ADJUSTING

- A. Adjust isolators after piping system is at operating weight.
- B. Adjust limit stops on restrained-spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

END OF SECTION 220548

SECTION 220553 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Equipment labels.
 - 2. Warning signs and labels.
 - 3. Pipe labels.
 - 4. Stencils.
 - 5. Valve tags.
 - 6. Warning tags.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- D. Valve numbering scheme.
- E. Valve Schedules: For each piping system to include in maintenance manuals.

1.4 COORDINATION

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
2. Letter Color: White.
3. Background Color: Black.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
7. Fasteners: Stainless-steel rivets.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include equipment's Drawing designation or unique equipment number.

C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.

B. Letter Color: White.

C. Background Color: Black.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

G. Fasteners: Stainless-steel rivets.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

- I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.3 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially cover circumference of pipe and to attach to pipe without fasteners or adhesive.
- C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
 1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
 2. Lettering Size: At least 1-1/2 inches high.

2.4 STENCILS

- A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; and minimum letter height of 3/4 inch for access panel and door labels, equipment labels, and similar operational instructions.
 1. Stencil Material: Aluminum .
 2. Stencil Paint: Exterior, gloss, alkyd enamel black unless otherwise indicated. Paint may be in pressurized spray-can form.
 3. Identification Paint: Exterior, alkyd enamel in colors according to ASME A13.1 unless otherwise indicated.

2.5 VALVE TAGS

- A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
 1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
 2. Fasteners: Brass wire-link or beaded chain; or S-hook.
- B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
 1. Valve-tag schedule shall be included in operation and maintenance data.

2.6 WARNING TAGS

- A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
 - 1. Size: Approximately 4 by 7 inches.
 - 2. Fasteners: Brass grommet and wire.
 - 3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
 - 4. Color: Yellow background with black lettering.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

- A. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1. Near each valve and control device.
 - 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 - 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
 - 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 - 5. Near major equipment items and other points of origination and termination.
 - 6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
 - 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.
- B. Pipe Label Color Schedule:
 - 1. Low-Pressure, Compressed-Air Piping:
 - a. Background Color: Black.
 - b. Letter Color: White.

3.4 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
 - 1. Valve-Tag Size and Shape:
 - a. Cold Water: 1-1/2 inches, round.
 - b. Hot Water: 1-1/2 inches, round.
 - 2. Valve-Tag Color:
 - a. Cold Water: Natural.
 - b. Hot Water: Natural.
 - 3. Letter Color:
 - a. Cold Water: Black.
 - b. Hot Water: Black.

3.5 WARNING-TAG INSTALLATION

- A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION 220553

SECTION 220719 - PLUMBING PIPING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.

1.2 SUMMARY

- A. Section includes insulating the following plumbing piping services:
 - 1. Domestic cold-water piping.
 - 2. Domestic hot-water piping.
 - 3. Supplies and drains for handicap-accessible lavatories and sinks.
- B. Related Sections:
 - 1. Section "Plumbing Equipment Insulation."

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied, if any).
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
 - 2. Detail attachment and covering of heat tracing inside insulation.
 - 3. Detail insulation application at pipe expansion joints for each type of insulation.
 - 4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
 - 5. Detail removable insulation at piping specialties, equipment connections, and access panels.
 - 6. Detail application of field-applied jackets.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

- C. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.
- C. Comply with the following applicable standards and other requirements specified for miscellaneous components:
 - 1. Supply and Drain Protective Shielding Guards: ICC A117.1.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.7 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section "Hangers and Supports for Plumbing Piping and Equipment."
- B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Coordinate installation and testing of heat tracing.

1.8 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Pittsburgh Corning Corporation; Foamglas.
 - b. Cell-U-Foam Insulation.
 - c. Manville.
 - 2. Block Insulation: ASTM C 552, Type I.
 - 3. Special-Shaped Insulation: ASTM C 552, Type III.
 - 4. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.
 - 5. Preformed Pipe Insulation with Factory-Applied ASJ: Comply with ASTM C 552, Type II, Class 2.
 - 6. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
 - 7. Minimum thickness of insulation shall comply with ANSI/ASHRAE/IES standard 90.1.latest addition, table 6.8.3a
 - 1. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials. Minimum thickness of insulation shall comply with ANSI/ASHRAE/IES standard 90.1.latest addition table 6.8.3a
- G.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Aeroflex USA, Inc.; Aerocel.
 - b. Armacell LLC; AP Armaflex.
 - c. K-Flex USA; Insul-Lock, Insul-Tube, and K-FLEX LS.

2. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type I. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article. Minimum thickness of insulation shall comply with ANSI/ASHRAE/IES standard 90.1. latest addition, table 6.8.3a.

H.

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. CertainTeed Corp.; SoftTouch Duct Wrap.
 - b. Johns Manville; Microlite.
 - c. Knauf Insulation; Friendly Feel Duct Wrap.
 - d. Manson Insulation Inc.; Alley Wrap.
 - e. Owens Corning; SOFTR All-Service Duct Wrap.

I. Mineral-Fiber, Preformed Pipe Insulation:

1. Products: Subject to compliance with requirements, provide one of the following: Minimum thickness of insulation shall comply with ANSI/ASHRAE/IES standard 90.1. latest addition, table 6.8.3a
 - a. Fibrex Insulations Inc.; Coreplus 1200.
 - b. Johns Manville; Micro-Lok.
 - c. Knauf Insulation; 1000-Degree Pipe Insulation.
 - d. Manson Insulation Inc.; Alley-K.
 - e. Owens Corning; Fiberglas Pipe Insulation.
2. Type I, 850 Deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.2 INSULATING CEMENTS

- A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.
- B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C 196.
- C. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.

2.3 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.
- B. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F.

1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- C. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.
1. Products: Subject to compliance with requirements, provide the following:
 - a. Aeroflex USA, Inc.; Aeroseal.
 - b. Armacell LLC; Armaflex 520 Adhesive.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-75.
 - d. K-Flex USA; R-373 Contact Adhesive.
 2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
1. Products: Subject to compliance with requirements, provide the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.
 - b. Eagle Bridges - Marathon Industries; 225.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.
 - d. Mon-Eco Industries, Inc.; 22-25.
 2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- E. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
1. Products: Subject to compliance with requirements, provide the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.
 - b. Eagle Bridges - Marathon Industries; 225.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-20.
 - d. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

F. PVC Jacket Adhesive: Compatible with PVC jacket.

1. Products: Subject to compliance with requirements, provide the following:
 - a. Dow Corning Corporation; 739, Dow Silicone.
 - b. Johns Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
 - c. P.I.C. Plastics, Inc.; Welding Adhesive.
 - d. Speedline Corporation; Polyco VP Adhesive.
2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.4 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.

1. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
2. Service Temperature Range: Minus 20 to plus 180 deg F.
3. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
4. Color: White.

C. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below-ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-30.
 - b. Eagle Bridges - Marathon Industries; 501.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-35.
 - d. Mon-Eco Industries, Inc.; 55-10.
2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 35-mil dry film thickness.
3. Service Temperature Range: 0 to 180 deg F.

4. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.
5. Color: White.

D. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below-ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Encacel.
 - b. Eagle Bridges - Marathon Industries; 570.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 60-95/60-96.
2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mil dry film thickness.
3. Service Temperature Range: Minus 50 to plus 220 deg F.
4. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
5. Color: White.

E. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-10.
 - b. Eagle Bridges - Marathon Industries; 550.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 46-50.
 - d. Mon-Eco Industries, Inc.; 55-50.
 - e. Vimasco Corporation; WC-1/WC-5.
2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: 60 percent by volume and 66 percent by weight.
5. Color: White.

2.5 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C, Class I, Grade A, and shall be compatible with insulation materials, jackets, and substrates.

1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-50 AHV2.
 - b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-36.
 - c. Vimasco Corporation; 713 and 714.

3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
4. Service Temperature Range: 0 to plus 180 deg F.
5. Color: White.

2.6 SEALANTS

A. Joint Sealants:

1. Joint Sealants for Cellular-Glass Products: Subject to compliance with requirements, provide one of the following :
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
 - b. Eagle Bridges - Marathon Industries; 405.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-45.
 - d. Mon-Eco Industries, Inc.; 44-05.
 - e. Pittsburgh Corning Corporation; Pittseal 444.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Permanently flexible, elastomeric sealant.
4. Service Temperature Range: Minus 100 to plus 300 deg F.
5. Color: White or gray.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. FSK and Metal Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide one of the following :
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
 - b. Eagle Bridges - Marathon Industries; 405.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44.
 - d. Mon-Eco Industries, Inc.; 44-05.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: Aluminum.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: White.
5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
6. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.7 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.8 FIELD-APPLIED FABRIC-REINFORCING MESH

- A. Woven Glass-Fiber Fabric: Approximately 2 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in. for covering pipe and pipe fittings.
- B. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in., in a Leno weave, for pipe.

2.9 FIELD-APPLIED CLOTHS

- A. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd..

2.10 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. Metal Jacket:

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Metal Jacketing Systems.
 - b. ITW Insulation Systems; Aluminum and Stainless Steel Jacketing.

- c. RPR Products, Inc.; Insul-Mate.
- 2. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
 - a. Sheet and roll stock ready for shop or field sizing.
 - b. Finish and thickness are indicated in field-applied jacket schedules.
 - c. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
 - d. Factory-Fabricated Fitting Covers:
 - 1) Same material, finish, and thickness as jacket.
 - 2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
 - 3) Tee covers.
 - 4) Flange and union covers.
 - 5) End caps.
 - 6) Beveled collars.
 - 7) Valve covers.
 - 8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

C. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

- 1. Width: 2 inches.
- 2. Thickness: 3.7 mils.
- 3. Adhesion: 100 ounces force/inch in width.
- 4. Elongation: 5 percent.
- 5. Tensile Strength: 34 lbf/inch in width.

2.11 SECUREMENTS

A. Bands:

- 1. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304; 0.015 inch thick, 3/4 inch wide.

B. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.

C. Wire: 0.080-inch nickel-copper alloy; 0.062-inch soft-annealed, stainless steel; or 0.062-inch soft-annealed, galvanized steel.

2.12 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers,:

- 1. Description: Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

B. Protective Shielding Piping Enclosures:

1. Description: Manufactured plastic enclosure for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with ADA requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
 1. Verify that systems to be insulated have been tested and are free of defects.
 2. Verify that surfaces to be insulated are clean and dry.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
 1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range between 140 and 300 deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
 2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
- C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:
 - 1. Draw jacket tight and smooth.
 - 2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 - 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
 - a. For below-ambient services, apply vapor-barrier mastic over staples.
 - 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
 - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

- M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- P. For above-ambient services, do not install insulation to the following:
 - 1. Vibration-control devices.
 - 2. Testing agency labels and stamps.
 - 3. Nameplates and data plates.
 - 4. Cleanouts.

3.4 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 - 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
 - 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
- C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 - 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
 - 4. Seal jacket to wall flashing with flashing sealant.
- D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

- E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
 - 1. Comply with requirements in Section "Penetration Firestopping" for firestopping and fire-resistive joint sealers.
- F. Insulation Installation at Floor Penetrations:
 - 1. Pipe: Install insulation continuously through floor penetrations.
 - 2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section "Penetration Firestopping."

3.5 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
 - 1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
 - 2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
 - 3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
 - 4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
 - 5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
 - 6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
 - 7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for

- above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
 9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
 2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
 3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
 4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
 5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.6 INSTALLATION OF CELLULAR-GLASS INSULATION

- A. Insulation Installation on Straight Pipes and Tubes:
1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
 2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
 3. For insulation with factory-applied jackets on above-ambient services, secure laps with outward clinched staples at 6 inches o.c.
 4. For insulation with factory-applied jackets on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.
- B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of cellular-glass insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.7 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.

2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.8 INSTALLATION OF MINERAL-FIBER INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.9 FIELD-APPLIED JACKET INSTALLATION

- A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.
 - 1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
 - 2. Embed glass cloth between two 0.062-inch- thick coats of lagging adhesive.
 - 3. Completely encapsulate insulation with coating, leaving no exposed insulation.
- B. Where FSK jackets are indicated, install as follows:
 - 1. Draw jacket material smooth and tight.
 - 2. Install lap or joint strips with same material as jacket.
 - 3. Secure jacket to insulation with manufacturer's recommended adhesive.
 - 4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
 - 5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.
- C. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive.
 - 1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- D. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.10 FINISHES

- A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section "Exterior Painting" and Section "Interior Painting."
 - 1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
 - a. Finish Coat Material: Interior, flat, latex-emulsion size.
- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- D. Do not field paint aluminum or stainless-steel jackets.

3.11 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections.
- C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.12 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
 - 1. Drainage piping located in crawl spaces.
 - 2. Underground piping.
 - 3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.13 INDOOR PIPING INSULATION SCHEDULE

- A. Domestic Cold Water:
 - 1. NPS 1 and Smaller: Insulation shall be one of the following:
 - a. Cellular Glass: 1-1/2 inches thick.
 - b. Flexible Elastomeric: 1/2 inch thick.
 - c. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.
 - 2. NPS 1-1/4 and Larger: Insulation shall be one of the following:
 - a. Cellular Glass: 1-1/2 inches thick.
 - b. Flexible Elastomeric: 1 inch thick.
 - c. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
- B. Domestic Hot and Recirculated Hot Water:
 - 1. NPS 1-1/4 and Smaller: Insulation shall be one of the following:
 - a. Cellular Glass: 1-1/2 inches thick.
 - b. Flexible Elastomeric: 3/4 inch thick.
 - c. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.
 - 2. NPS 1-1/2 and Larger: Insulation shall be one of the following:
 - a. Cellular Glass: 1-1/2 inches thick.
 - b. Flexible Elastomeric: 1 inch thick.
 - c. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

- C. Domestic Chilled Water (Potable):
 - 1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Cellular Glass: 1-1/2 inches thick.
 - b. Flexible Elastomeric: 1 inch thick.
 - c. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
- D. Roof Drain and Overflow Drain Bodies:
 - 1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Cellular Glass: 1-1/2 inches thick.
 - b. Flexible Elastomeric: 1 inch thick.
 - c. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
- E. Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Flexible Elastomeric: 3/4 inch thick.
 - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
- F. Floor Drains, Traps, and Sanitary Drain Piping within 10 Feet of Drain Receiving Condensate and Equipment Drain Water below 60 Deg F:
 - 1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Cellular Glass: 1-1/2 inches thick.
 - b. Flexible Elastomeric: 1 inch thick.
 - c. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

3.14 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

- A. Domestic Water Piping:
 - 1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Cellular Glass: 2 inches thick.
 - b. Flexible Elastomeric: 2 inches thick.
 - c. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.
- B. Domestic Hot and Recirculated Hot Water:
 - 1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Cellular Glass: 2 inches thick.
 - b. Flexible Elastomeric: 2 inches thick.
 - c. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.

3.15 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. Piping, Exposed:
 - 1. Aluminum, Smooth: 0.016 inch thick.

END OF SECTION 220719

SECTION 221116 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Under-building-slab and aboveground domestic water pipes, tubes, and fittings inside buildings.
 - 2. Encasement for piping.

1.3 INFORMATIONAL SUBMITTALS

- A. System purging and disinfecting activities report.
- B. Field quality-control reports.

1.4 FIELD CONDITIONS

- A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:
 - 1. Notify Architect no fewer than two days in advance of proposed interruption of water service.
 - 2. Do not interrupt water service without Architect's/Engineer written permission.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.
- B. Potable-water piping and components shall comply with NSF 14 and NSF 61. Plastic piping components shall be marked with "NSF-pw."

2.2 COPPER TUBE AND FITTINGS

- A. Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper.
- B. Soft Copper Tube: ASTM B 88, Type K and ASTM B 88, Type L water tube, annealed temper.
- C. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.
- D. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
- E. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
- F. Copper Unions:
 - 1. MSS SP-123.
 - 2. Cast-copper-alloy, hexagonal-stock body.
 - 3. Ball-and-socket, metal-to-metal seating surfaces.
 - 4. Solder-joint or threaded ends.
- G. Copper Pressure-Seal-Joint Fittings:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Elkhart Products Corporation.
 - b. NIBCO Inc.
 - c. Viega.
 - d. T-Drill
 - 2. Fittings for NPS 2 and Smaller: Wrought-copper fitting with EPDM-rubber, O-ring seal in each end.
- H. Copper Push-on-Joint Fittings:
 - 1. Description:
 - a. Cast-copper fitting complying with ASME B16.18 or wrought-copper fitting complying with ASME B 16.22.
 - b. Stainless-steel teeth and EPDM-rubber, O-ring seal in each end instead of solder-joint ends.
- I. Copper-Tube, Extruded-Tee Connections:
 - 1. Description: Tee formed in copper tube according to ASTM F 2014.
 - 2. Mechanically formed extruded outlets shall be perpendicular to the axis of the tub run (header). The inner branch tube end shall conform to the shape of the inner curve of the run tube and shall conform to ASTM F-2014. Forming procedures shall be in accordance the tool manufacturer's recommendations.
- J. Appurtenances for Grooved-End Copper Tubing:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Anvil International.
 - b. Shurjoint Piping Products.
 - c. Victaulic Company.
2. Bronze Fittings for Grooved-End, Copper Tubing: ASTM B 75 copper tube or ASTM B 584 bronze castings.

2.3 CPVC PIPING

- A. CPVC Pipe: ASTM F 441/F 441M, Schedule 40 and Schedule 80.
 1. CPVC Socket Fittings: ASTM F 438 for Schedule 40 and ASTM F 439 for Schedule 80.
 2. CPVC Threaded Fittings: ASTM F 437, Schedule 80.
- B. CPVC Piping System: ASTM D 2846/D 2846M, SDR 11, pipe and socket fittings.
- C. CPVC Tubing System: ASTM D 2846/D 2846M, SDR 11, tube and socket fittings.

2.4 PVC PIPE AND FITTINGS

- A. PVC Pipe: ASTM D 1785, Schedule 40 and Schedule 80.
- B. PVC Socket Fittings: ASTM D 2466 for Schedule 40 and ASTM D 2467 for Schedule 80.
- C. PVC Schedule 80 Threaded Fittings: ASTM D 2464.

2.5 PIPING JOINING MATERIALS

- A. Pipe-Flange Gasket Materials:
 1. AWWA C110/A21.10, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free unless otherwise indicated.
 2. Full-face or ring type unless otherwise indicated.
- B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- C. Solder Filler Metals: ASTM B 32, lead-free alloys.
- D. Flux: ASTM B 813, water flushable.
- E. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.
- F. Solvent Cements for Joining CPVC Piping and Tubing: ASTM F 493.

1. CPVC solvent cement shall have a VOC content of 490 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 2. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 3. Solvent cement and adhesive primer shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- G. Solvent Cements for Joining PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
1. PVC solvent cement shall have a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 2. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 3. Solvent cement and adhesive primer shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- H. Plastic, Pipe-Flange Gaskets, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

2.6 TRANSITION FITTINGS

- A. General Requirements:
1. Same size as pipes to be joined.
 2. Pressure rating at least equal to pipes to be joined.
 3. End connections compatible with pipes to be joined.
- B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
- C. Sleeve-Type Transition Coupling: AWWA C219.
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Cascade Waterworks Manufacturing.
 - b. Dresser, Inc.; Piping Specialties Products.
 - c. Ford Meter Box Company, Inc. (The).
 - d. JCM Industries.
 - e. Romac Industries, Inc.
 - f. Smith-Blair, Inc.; a Sensus company.
 - g. Viking Johnson.
- D. Plastic-to-Metal Transition Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Charlotte Pipe and Foundry Company.
 - b. Harvel Plastics, Inc.
 - c. Spears Manufacturing Company.
2. Description:
 - a. CPVC] or PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions.
 - b. One end with threaded brass insert and one solvent-cement-socket or threaded end.

E. Plastic-to-Metal Transition Unions:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Colonial Engineering, Inc.
 - b. NIBCO Inc.
 - c. Spears Manufacturing Company.
2. Description:
 - a. CPVC] or PVC four-part union.
 - b. Brass threaded end.
 - c. Solvent-cement-joint plastic end.
 - d. Rubber O-ring.
 - e. Union nut.

2.7 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Capitol Manufacturing Company; member of the Phoenix Forge Group.
 - b. Central Plastics Company.
 - c. Hart Industries International, Inc.
 - d. Jomar International.
 - e. Matco-Norca.
 - f. McDonald, A. Y. Mfg. Co.
 - g. Watts; a division of Watts Water Technologies, Inc.
 - h. Wilkins; a Zurn company.
2. Standard: ASSE 1079.

3. Pressure Rating: 150 psig.
4. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Capitol Manufacturing Company; member of the Phoenix Forge Group.
 - b. Central Plastics Company.
 - c. Matco-Norca.
 - d. Watts; a division of Watts Water Technologies, Inc.
 - e. Wilkins; a Zurn company.
2. Standard: ASSE 1079.
3. Factory-fabricated, bolted, companion-flange assembly.
4. Pressure Rating: 150 psig.
5. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Central Plastics Company.
 - d. Pipeline Seal and Insulator, Inc.
2. Nonconducting materials for field assembly of companion flanges.
3. Pressure Rating: 150 psig.
4. Gasket: Neoprene or phenolic.
5. Bolt Sleeves: Phenolic or polyethylene.
6. Washers: Phenolic with steel backing washers.

E. Dielectric Nipples:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Elster Perfection Corporation.
 - b. Grinnell Mechanical Products; Tyco Fire Products LP.
 - c. Matco-Norca.
 - d. Precision Plumbing Products, Inc.
 - e. Victaulic Company.
2. Standard: IAPMO PS 66.
3. Electroplated steel nipple complying with ASTM F 1545.
4. Pressure Rating and Temperature: 300 psig at 225 deg F.
5. End Connections: Male threaded or grooved.

6. Lining: Inert and noncorrosive, propylene.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."
- C. Install ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.
- D. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve inside the building at each domestic water-service entrance. Comply with requirements for pressure gages in Section "Meters and Gages for Plumbing Piping" and with requirements for drain valves and strainers in Section "Domestic Water Piping Specialties."
- E. Install shutoff valve immediately upstream of each dielectric fitting.
- F. Install domestic water piping level with 0.25 percent slope downward toward drain and plumb.
- G. Rough-in domestic water piping for water-meter installation according to utility company's requirements.
- H. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices in Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- I. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- J. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- K. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.
- L. Install piping to permit valve servicing.
- M. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.
- N. Install piping free of sags and bends.
- O. Install fittings for changes in direction and branch connections.

- P. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.
- Q. Install thermometers on inlet and outlet piping from each water heater. Comply with requirements for thermometers in Section "Meters and Gages for Plumbing Piping."
- R. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section "Sleeves and Sleeve Seals for Plumbing Piping."
- S. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section "Sleeves and Sleeve Seals for Plumbing Piping."
- T. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section "Escutcheons for Plumbing Piping."

3.2 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 1. Apply appropriate tape or thread compound to external pipe threads.
 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- D. Brazed Joints for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Brazed Joints" chapter.
- E. Soldered Joints for Copper Tubing: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."
- F. Pressure-Sealed Joints for Copper Tubing: Join copper tube and pressure-seal fittings with tools recommended by fitting manufacturer.
- G. Push-on Joints for Copper Tubing: Clean end of tube. Measure insertion depth with manufacturer's depth gage. Join copper tube and push-on-joint fittings by inserting tube to measured depth.
- H. Extruded-Tee Connections: Form tee in copper tube according to ASTM F 2014. Use tool designed for copper tube; drill pilot hole, form collar for outlet, dimple tube to form seating stop, and braze branch tube into collar.
- I. Joint Construction for Grooved-End Copper Tubing: Make joints according to AWWA C606. Roll groove ends of tubes. Lubricate and install gasket over ends of tubes or tube and fitting.

Install coupling housing sections over gasket with keys seated in tubing grooves. Install and tighten housing bolts.

- J. Joint Construction for Grooved-End, Ductile-Iron Piping: Make joints according to AWWA C606. Cut round-bottom grooves in ends of pipe at gasket-seat dimension required for specified (flexible or rigid) joint. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections over gasket with keys seated in piping grooves. Install and tighten housing bolts.
- K. Joint Construction for Grooved-End Steel Piping: Make joints according to AWWA C606. Square cut or Roll groove ends of pipe as specified. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections over gasket with keys seated in piping grooves. Install and tighten housing bolts.
- L. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.
- M. Joint Construction for Solvent-Cemented Plastic Piping: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 - 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements. Apply primer.
 - 2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
 - 3. PVC Piping: Join according to ASTM D 2855.
- N. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

3.3 TRANSITION FITTING INSTALLATION

- A. Install transition couplings at joints of dissimilar piping.
- B. Transition Fittings in Underground Domestic Water Piping:
 - 1. Fittings for NPS 1-1/2 and Smaller: Fitting-type coupling.
- C. Transition Fittings in Aboveground Domestic Water Piping NPS 2 and Smaller: Plastic-to-metal transition fittings or unions.

3.4 DIELECTRIC FITTING INSTALLATION

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric couplings or nipples.

3.5 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for seismic-restraint devices in Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- B. Comply with requirements for pipe hanger, support products, and installation in Section "Hangers and Supports for Plumbing Piping and Equipment."
 - 1. Vertical Piping: MSS Type 8 or 42, clamps.
 - 2. Individual, Straight, Horizontal Piping Runs:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
 - 3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 - 4. Base of Vertical Piping: MSS Type 52, spring hangers.
- C. Support vertical piping and tubing at base and at each floor.
- D. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.
- E. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
 - 2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
 - 3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
- F. Install supports for vertical copper tubing every 10 feet.
- G. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/4 and Smaller: 84 inches with 3/8-inch rod.
 - 2. NPS 1-1/2: 108 inches with 3/8-inch rod.
 - 3. NPS 2: 10 feet with 3/8-inch rod.
- H. Install supports for vertical CPVC piping every 60 inches for NPS 1 and smaller, and every 72 inches for NPS 1-1/4 and larger.
 - 1. NPS 1 and Smaller: 32 inches with 3/8-inch rod.
- I. Install vinyl-coated hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 2 and Smaller: 48 inches with 3/8-inch rod.
 - 2. NPS 2-1/2 to NPS 3-1/2: 48 inches with 1/2-inch rod.
- J. Install supports for vertical PVC piping every 48 inches.

- K. Install vinyl-coated hangers for PP piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1 and Smaller: 36 inches with 3/8-inch rod.
 - 2. NPS 1-1/4 to NPS 2: 48 inches with 3/8-inch rod.
- L. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

3.6 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.
- C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.
- D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
 - 1. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
 - 2. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.
 - 3. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection.

3.7 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification materials and installation in Section "Identification for Plumbing Piping and Equipment."
- B. Label pressure piping with system operating pressure.

3.8 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Piping Inspections:
 - a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
 - b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
 - 1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.

- 2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.
 - c. Re-inspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for re-inspection.
 - d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
2. Piping Tests:
- a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
 - b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
 - c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - d. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
 - e. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
 - f. Prepare reports for tests and for corrective action required.
- B. Domestic water piping will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

3.9 ADJUSTING

- A. Perform the following adjustments before operation:
- 1. Close drain valves, hydrants, and hose bibbs.
 - 2. Open shutoff valves to fully open position.
 - 3. Open throttling valves to proper setting.
 - 4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
 - a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
 - b. Adjust calibrated balancing valves to flows indicated.
 - 5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
 - 6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
 - 7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
 - 8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.10 CLEANING

- A. Clean and disinfect potable domestic water piping as follows:
 - 1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
 - 2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
 - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b. Fill and isolate system according to either of the following:
 - 1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
 - 2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
 - c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
 - d. Repeat procedures if biological examination shows contamination.
 - e. Submit water samples in sterile bottles to authorities having jurisdiction.
- B. Clean non-potable domestic water piping as follows:
 - 1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
 - 2. Use purging procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:
 - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.
- C. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.
- D. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.11 PIPING SCHEDULE

- A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
- B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.
- C. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.

- D. Under-building-slab, domestic water, building-service piping, NPS 3 and smaller, shall be one of the following:
 - 1. Soft copper tube, ASTM B 88, Type K; wrought-copper, solder-joint fittings; and brazed joints.
 - 2. PVC, Schedule 40; socket fittings; and solvent-cemented joints.
- E. Under-building-slab, domestic water piping, NPS 2 and smaller, shall be one of the following:
 - 1. Soft copper tube, ASTM B 88, Type L; wrought-copper, solder-joint fittings; and brazed joints.
 - 2. PVC, Schedule 40; socket fittings; and solvent-cemented joints.
- F. Aboveground domestic water piping, NPS 2 and smaller, shall be one of the following:
 - 1. Hard copper tube, ASTM B 88, Type L; wrought-copper, solder-joint fittings; and soldered joints.
 - 2. Hard copper tube, ASTM B 88, Type L; copper pressure-seal-joint fittings; and pressure-sealed joints.
 - 3. Hard copper tube, ASTM B 88, Type L; copper push-on-joint fittings; and push-on joints.
 - 4. CPVC, Schedule 40; socket fittings; and solvent-cemented joints.
 - 5. CPVC, Schedule 80 pipe; CPVC, Schedule 80 threaded fittings; and threaded joints.
 - 6. CPVC Tubing System: CPVC tube; CPVC socket fittings; and solvent-cemented joints.
 - 7. PVC, Schedule 40; socket fittings; and solvent-cemented joints.

3.12 VALVE SCHEDULE

- A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
 - 1. Shutoff Duty: Use ball or gate valves for piping NPS 2 and smaller.
 - 2. Throttling Duty: Use ball or globe valves for piping NPS 2 and smaller.
 - 3. Hot-Water Circulation Piping, Balancing Duty: Memory-stop balancing valves.
 - 4. Drain Duty: Hose-end drain valves.
- B. Use check valves to maintain correct direction of domestic water flow to and from equipment.
- C. Iron grooved-end valves may be used with grooved-end piping.

END OF SECTION 221116

SECTION 221119 - DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

1. Vacuum breakers.
2. Strainers.
3. Hose bibbs.
4. Wall hydrants.
5. Drain valves.
6. Water-hammer arresters.
7. .

- B. Related Requirements:

1. Section "Meters and Gages for Plumbing Piping" for thermometers, pressure gages, and flow meters in domestic water piping.
2. Section "Domestic Water Piping" for water meters.
3. Section "Emergency Plumbing Fixtures" for water tempering equipment.
4. Section "Pressure Water Coolers" for water filters for water coolers.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For domestic water piping specialties.
 1. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

- A. Potable-water piping and components shall comply with NSF 61 Annex G and NSF 14.

2.2 PERFORMANCE REQUIREMENTS

- A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig unless otherwise indicated.

2.3 VACUUM BREAKERS

- A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Ames Fire & Waterworks; a division of Watts Water Technologies, Inc.
 - b. Cash Acme; a division of Reliance Worldwide Corporation.
 - c. Conbraco Industries, Inc.
 - d. FEBCO; a division of Watts Water Technologies, Inc.
 - e. Rain Bird Corporation.
 - f. Toro Company (The); Irrigation Div.
 - g. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
 - h. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
2. Standard: ASSE 1001.
3. Size: NPS 1/4 to NPS 3, as required to match connected piping.
4. Body: Bronze.
5. Inlet and Outlet Connections: Threaded.
6. Finish: Rough bronze.

- B. Hose-Connection Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Arrowhead Brass Products.
 - b. Cash Acme; a division of Reliance Worldwide Corporation.
 - c. Conbraco Industries, Inc.
 - d. Legend Valve.
 - e. MIFAB, Inc.
 - f. Prier Products, Inc.
 - g. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
 - h. Woodford Manufacturing Company; a division of WCM Industries, Inc.
 - i. Zurn Industries, LLC; Plumbing Products Group; Light Commercial Products.
 - j. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.

2. Standard: ASSE 1011.
3. Body: Bronze, nonremovable, with manual drain.
4. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
5. Finish: Chrome or nickel plated.

C. Pressure Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Ames Fire & Waterworks; a division of Watts Water Technologies, Inc.
 - b. Conbraco Industries, Inc.
 - c. FEBCO; a division of Watts Water Technologies, Inc.
 - d. Flomatic Corporation.
 - e. Toro Company (The); Irrigation Div.
 - f. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
 - g. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
2. Standard: ASSE 1020.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: 5 psig maximum, through middle third of flow range.
5. Size: Match pipe size.
6. Accessories:
 - a. Valves: Ball type, on inlet and outlet.

D. Hose-Connection Backflow Preventers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Conbraco Industries, Inc.
 - b. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
 - c. Woodford Manufacturing Company; a division of WCM Industries, Inc.
2. Standard: ASSE 1052.
3. Operation: Up to 10-foot head of water back pressure.
4. Inlet Size: NPS 1/2 or NPS 3/4.
5. Outlet Size: Garden-hose thread complying with ASME B1.20.7.
6. Capacity: At least 3-gpm flow.

2.4 TEMPERATURE-ACTUATED, WATER MIXING VALVES

- A. Primary, Thermostatic, Water Mixing Valves:
- B. -Valve Assemblies.
- C. Individual-Fixture, Water Tempering Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Cash Acme; a division of Reliance Worldwide Corporation.
 - b. Conbraco Industries, Inc.
 - c. Honeywell International Inc.
 - d. Lawler Manufacturing Company, Inc.
 - e. Leonard Valve Company.
 - f. Powers; a division of Watts Water Technologies, Inc.
 - g. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
 - h. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
2. Standard: ASSE 1016, thermostatically controlled, water tempering valve.
3. Pressure Rating: 125 psig minimum unless otherwise indicated.
4. Body: Bronze body with corrosion-resistant interior components.
5. Temperature Control: Adjustable.
6. Inlets and Outlet: Threaded.
7. Finish: Rough or chrome-plated bronze.

2.5 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:

1. Pressure Rating: 125 psig minimum unless otherwise indicated.
2. Body: Bronze for NPS 2 and smaller; cast iron[with interior lining that complies with AWWA C550 or that is FDA approved, epoxy coated and] for NPS 2-1/2 and larger.
3. End Connections: Threaded for NPS 2 and smaller.
4. Screen: Stainless steel with round perforations unless otherwise indicated.
5. Perforation Size:
 - a. Strainers NPS 2 and Smaller:[0.020 inch

2.6 OUTLET BOXES

A. Icemaker Outlet Boxes:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Acorn Engineering Company.
 - b. IPS Corporation.
 - c. LSP Products Group, Inc.
 - d. Oatey.
 - e. Plastic Oddities.
2. Mounting: Recessed.
3. Material and Finish: [Enameled-steel or epoxy-painted-steel] Plastic box and faceplate.
4. Faucet: Valved fitting complying with ASME A112.18.1. Include NPS 1/2 or smaller copper tube outlet.

5. Supply Shutoff Fitting: NPS 1/2 gate, globe, or ball valve and NPS 1/2 copper, water tubing.

B. Hose Bibbs:

1. Standard: ASME A112.18.1 for sediment faucets.
2. Body Material: Bronze.
3. Seat: Bronze, replaceable.
4. Supply Connections: NPS 1/2 or NPS 3/4 threaded or solder-joint inlet.
5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
6. Pressure Rating: 125 psig.
7. Vacuum Breaker: Integral non-removable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
8. Finish for Finished Rooms: Chrome or nickel plated.
9. Operation for Equipment Rooms: Wheel handle or operating key.
10. Operation for Service Areas: Wheel handle.
11. Operation for Finished Rooms: Operating key.
12. Include operating key with each operating-key hose bibb.
13. Include integral wall flange with each chrome- or nickel-plated hose bibb.

2.7 WALL HYDRANTS

A. Nonfreeze Wall Hydrants:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Josam Company.
 - b. MIFAB, Inc.
 - c. Prier Products, Inc.
 - d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - e. Tyler Pipe; Wade Div.
 - f. Watts Drainage Products.
 - g. Woodford Manufacturing Company; a division of WCM Industries, Inc.
 - h. Zurn Industries, LLC; Plumbing Products Group; Light Commercial Products.
 - i. Zurn Industries, LLC; Plumbing Products Group; Specification Drainage Products.
2. Standard: ASME A112.21.3M for concealed]-outlet, self-draining wall hydrants.
3. Pressure Rating: 125 psig.
4. Operation: Loose key.
5. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
6. Inlet: NPS 3/4 or NPS 1.
7. Outlet: Concealed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
8. Box: Deep, flush mounted with cover.
9. Box and Cover Finish: Chrome plated.
10. Outlet: Exposed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
11. Nozzle and Wall-Plate Finish: [Polished nickel bronze.

12. Operating Keys(s): Two with each wall hydrant.

B. Moderate-Climate Wall Hydrants:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Josam Company.
- b. MIFAB, Inc.
- c. Prier Products, Inc.
- d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
- e. Tyler Pipe; Wade Div.
- f. Watts Drainage Products.
- g. Woodford Manufacturing Company; a division of WCM Industries, Inc.
- h. Zurn Industries, LLC; Plumbing Products Group; Light Commercial Products.
- i. Zurn Industries, LLC; Plumbing Products Group; Specification Drainage Products.

2. Standard: ASME A112.21.3M for concealed outlet, self-draining wall hydrants.

3. Pressure Rating: 125 psig.

4. Operation: Loose key.

5. Inlet: NPS 3/4 or NPS 1.

6. Outlet:

- a. Concealed, with integral vacuum breaker or nonremovable hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052.
- b. Garden-hose thread complying with ASME B1.20.7.

7. Box: Deep, flush mounted with cover.

8. Box and Cover Finish: [Polished nickel bronze] [Chrome plated].

9. Outlet:

- a. Concealed, with integral vacuum breaker or nonremovable hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052.
- b. Garden-hose thread complying with ASME B1.20.7.

10. Nozzle and Wall-Plate Finish: Polished nickel bronze.

11. Operating Keys(s): Two with each wall hydrant.

C. Vacuum Breaker Wall Hydrants:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Arrowhead Brass Products.
- b. Mansfield Plumbing Products LLC.
- c. McDonald, A. Y. Mfg. Co.
- d. Prier Products, Inc.
- e. Smith, Jay. R. Mfg. Co.; Division of Smith Industries, Inc.
- f. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
- g. Woodford Manufacturing Company; a division of WCM Industries, Inc.
- h. Zurn Industries, LLC; Plumbing Products Group; Light Commercial Products.

2. Standard: ASSE 1019, Type A or Type B.

3. Type: Freeze-resistant, automatic draining with integral air-inlet valve.
4. Classification: Type B, for automatic draining with hose removed or with hose attached and nozzle closed.
5. Pressure Rating: 125 psig.
6. Operation: Loose key.
7. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
8. Inlet: NPS 1/2 or NPS 3/4.
9. Outlet: Exposed with garden-hose thread complying with ASME B1.20.7.

2.8 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:

1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
2. Pressure Rating: 400-psig minimum CWP.
3. Size: NPS 3/4.
4. Body: Copper alloy.
5. Ball: Chrome-plated brass.
6. Seats and Seals: Replaceable.
7. Handle: Vinyl-covered steel.
8. Inlet: Threaded or solder joint.
9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

B. Gate-Valve-Type, Hose-End Drain Valves:

1. Standard: MSS SP-80 for gate valves.
2. Pressure Rating: Class 125.
3. Size: NPS 3/4.
4. Body: ASTM B 62 bronze.
5. Inlet: NPS 3/4 threaded or solder joint.
6. Outlet: Garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

C. Stop-and-Waste Drain Valves:

1. Standard: MSS SP-110 for ball valves or MSS SP-80 for gate valves.
2. Pressure Rating: 200-psig minimum CWP or Class 125.
3. Size: NPS 3/4.
4. Body: Copper alloy or ASTM B 62 bronze.
5. Drain: NPS 1/8 side outlet with cap.

2.9 WATER-HAMMER ARRESTERS

A. Water-Hammer Arresters:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AMTROL, Inc.
 - b. Josam Company.
 - c. MIFAB, Inc.
 - d. Precision Plumbing Products, Inc.
 - e. Sioux Chief Manufacturing Company, Inc.
 - f. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - g. Tyler Pipe; Wade Div.
 - h. Watts Drainage Products.
 - i. Zurn Industries, LLC; Plumbing Products Group; Specification Drainage Products.
2. Standard: ASSE 1010 or PDI-WH 201.
3. Type: Copper tube with piston].
4. Size: ASSE 1010, Sizes AA and A through F, or PDI-WH 201, Sizes A through F.

2.10 AIR VENTS

A. Bolted-Construction Automatic Air Vents:

1. Body: Bronze.
2. Pressure Rating and Temperature: 125-psig minimum pressure rating at 140 deg F.
3. Float: Replaceable, corrosion-resistant metal.
4. Mechanism and Seat: Stainless steel.
5. Size: NPS 3/8] minimum inlet.
6. Inlet and Vent Outlet End Connections: Threaded.

B. Welded-Construction Automatic Air Vents:

1. Body: Stainless steel.
2. Pressure Rating: 150-psig minimum pressure rating.
3. Float: Replaceable, corrosion-resistant metal.
4. Mechanism and Seat: Stainless steel.
5. Size: NPS 3/8 minimum inlet.
6. Inlet and Vent Outlet End Connections: Threaded.

C. CPVC Union Ball Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Valve, Inc.
 - b. Asahi/America.
 - c. Colonial Engineering, Inc.
 - d. Georg Fischer LLC; GF Piping Systems.
 - e. Hayward Flow Control Systems; Hayward Industrial Products, Inc.
 - f. IPEX.
 - g. NIBCO Inc.
 - h. Spears Manufacturing Company.
 - i. Thermoplastic Valves Inc.

2. Description:
 - a. Standard: MSS SP-122.
 - b. Pressure Rating and Temperature: [150 psig at 73 deg F.
 - c. Body Material: CPVC.
 - d. Body Design: Union type.
 - e. End Connections for Valves NPS 2 and Smaller: Detachable, threaded.
 - f. End Connections for Valves NPS 2-1/2 to NPS 4: Detachable, socket or threaded threaded.
 - g. Ball: CPVC; full port.
 - h. Seals: PTFE or EPDM-rubber O-rings.
 - i. Handle: Tee shaped.

D. PVC Union Ball Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Valve, Inc.
 - b. Asahi/America.
 - c. Colonial Engineering, Inc.
 - d. Georg Fischer LLC; GF Piping Systems.
 - e. Hayward Flow Control Systems; Hayward Industrial Products, Inc.
 - f. IPEX.
 - g. Jomar International.
 - h. KBI Company.
 - i. Legend Valve.
 - j. McDonald, A. Y. Mfg. Co.
 - k. NIBCO Inc.
 - l. Spears Manufacturing Company.
 - m. Thermoplastic Valves Inc.
2. Description:
 - a. Standard: MSS SP-122.
 - b. Pressure Rating and Temperature:] 150 psig at 73 deg F.
 - c. Body Material: PVC.
 - d. Body Design: Union type.
 - e. End Connections for Valves NPS 2 and Smaller: Detachable,] threaded.
 - f. End Connections for Valves NPS 2-1/2 to NPS 4: Detachable, threaded.
 - g. Ball: PVC; full port.
 - h. Seals: PTFE or EPDM-rubber O-rings.
 - i. Handle: Tee shaped.

E. CPVC Ball Check Valves:

- a. Manufacturers: Subject to compliance with requirements, provide products by one of the following.

F. CPVC Gate Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Georg Fischer LLC; GF Piping Systems.
 - b. Spears Manufacturing Company.
 - c. <Insert manufacturer's name>.

2. Description:
 - a. Pressure Rating and Temperature: 150 psig at 73 deg F.
 - b. Body Material: CPVC.
 - c. Body Design: Nonrising stem.
 - d. End Connections for Valves NPS 2 and Smaller: threaded.
 - e. End Connections for Valves NPS 2-1/2 to NPS 4: Threaded.
 - f. Gate and Stem: Plastic.
 - g. Seals: EPDM rubber.
 - h. Handle: Wheel.

G. PVC Gate Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Asahi/America.
 - b. Georg Fischer LLC; GF Piping Systems.
 - c. KBI Company.
 - d. Spears Manufacturing Company.

2. Description:
 - a. Pressure Rating and Temperature: 150 psig at 73 deg F.
 - b. Body Material: PVC.
 - c. Body Design: Nonrising stem.
 - d. End Connections for Valves NPS 2 and Smaller: threaded.
 - e. End Connections for Valves NPS 2-1/2 to NPS 4 Threaded.
 - f. Gate and Stem: Plastic.
 - g. Seals: EPDM rubber.
 - h. Handle: Wheel.

2.11 FLEXIBLE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Flex-Hose Co., Inc.
2. Flexicraft Industries.
3. Flex Pression, Ltd.
4. Flex-Weld Incorporated.
5. Hyspan Precision Products, Inc.
6. Mercer Gasket & Shim, Inc.
7. Metraflex, Inc.
8. Proco Products, Inc.

9. TOZEN Corporation.
 10. Unaflex.Universal Metal Hose; a Hyspan company.
- B. Bronze-Hose Flexible Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.
1. Working-Pressure Rating: Minimum [200 psig].
 2. End Connections NPS 2 and Smaller: Threaded copper pipe or plain-end copper tube.
 3. End Connections NPS 2-1/2 and Larger: Flanged copper alloy.
- C. Stainless-Steel-Hose Flexible Connectors: Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing.
1. Working-Pressure Rating: Minimum 200 psig].
 2. End Connections NPS 2 and Smaller: Threaded steel-pipe nipple.
 3. End Connections NPS 2-1/2 and Larger: Flanged steel nipple.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
1. Locate backflow preventers in same room as connected equipment or system.
 2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe-to-floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are unacceptable for this application.
 3. Do not install bypass piping around backflow preventers.
- B. Install water regulators with inlet and outlet shutoff valves. Install pressure gages on inlet and outlet.
- C. Install water-control valves with inlet and outlet shutoff valves. Install pressure gages on inlet and outlet.
- D. Install balancing valves in locations where they can easily be adjusted.
- E. Install temperature-actuated, water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.
1. Install cabinet-type units recessed in or surface mounted on wall as specified.
- F. Install outlet boxes recessed in wall or surface mounted on wall. Install 2-by-4-inch fire-retardant-treated-wood blocking, wall reinforcement between studs. Comply with requirements for fire-retardant-treated-wood blocking in Section "Rough Carpentry."

- G. Install hose stations with check stops or shutoff valves on inlets and with thermometer on outlet.
 - 1. Install cabinet-type units recessed in or surface mounted on wall as specified. Install 2-by-4-inch fire-retardant-treated-wood blocking, wall reinforcement between studs. Comply with requirements for fire-retardant-treated-wood blocking in Section 061000 "Rough Carpentry."
- H. Install water-hammer arresters in water piping according to PDI-WH 201.
- I. Install air vents at high points of water piping. Install drain piping and discharge onto floor drain.
- J. Install supply-type, trap-seal primer valves with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.
- K. Install drainage-type, trap-seal primer valves as lavatory trap with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting.
- L. Install trap-seal primer systems with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust system for proper flow.

3.2 CONNECTIONS

- A. Comply with requirements for ground equipment in Section "Grounding and Bonding for Electrical Systems."
- B. Fire-retardant-treated-wood blocking is specified in Section "Low-Voltage Electrical Power Conductors and Cables" for electrical connections.

3.3 LABELING AND IDENTIFYING

3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Test each pressure vacuum breaker] according to authorities having jurisdiction and the device's reference standard.
- B. Domestic water piping specialties will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

3.5 ADJUSTING

- A. Set field-adjustable pressure set points of water pressure-reducing valves.

- B. Set field-adjustable flow set points of balancing valves.
- C. Set field-adjustable temperature set points of temperature-actuated, water mixing valves.

END OF SECTION 221119

SECTION 221316 - SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

- 1. Pipe, tube, and fittings.
- 2. Specialty pipe fittings.
- 3. Encasement for underground metal piping.

- B. Related Sections:

- 1. Section "Facility Sanitary Sewers" for sanitary sewerage piping and structures outside the building.

1.3 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:

- 1. Soil, Waste, and Vent Piping: 10-foot head of water.

- B. Seismic Performance: Soil, waste, and vent piping and support and installation shall withstand the effects of earthquake motions determined, according to ASCE/SEI 7.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For solvent drainage system. Include plans, elevations, sections, and details.

1.5 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Certificates: For waste and vent piping, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Detailed description of piping anchorage devices on which the certification is based and their installation requirements.

B. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF/ANSI 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-DWV" for plastic drain, waste, and vent piping and "NSF-sewer" for plastic sewer piping.

1.7 PROJECT CONDITIONS

A. Interruption of Existing Sanitary Waste Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify Architect no fewer than two days in advance of proposed interruption of sanitary waste service.
2. Do not proceed with interruption of sanitary waste service without Architect's or Owner's written permission.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.2 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 74, Service class(es).

B. Gaskets: ASTM C 564, rubber.

C. Calking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

2.3 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 888 or CISPI 301.

- B. Solvent Stack Fittings: ASME B16.45 or ASSE 1043, hubless, cast-iron aerator and deaerator drainage fittings.
- C. CISPI, Hubless-Piping Couplings:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ANACO-Husky.
 - b. Dallas Specialty & Mfg. Co.
 - c. Fernco Inc.
 - d. Matco-Norca, Inc.
 - e. MIFAB, Inc.
 - f. Mission Rubber Company; a division of MCP Industries, Inc.
 - g. Stant.
 - h. Tyler Pipe.
 - 2. Standards: ASTM C 1277 and CISPI 310.
 - 3. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.
- D. Cast-Iron, Hubless-Piping Couplings:
 - 1. Standard: ASTM C 1277.
 - 2. Description: Two-piece ASTM A 48/A 48M, cast-iron housing; stainless-steel bolts and nuts; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.4 GALVANIZED-STEEL PIPE AND FITTINGS

- A. Galvanized-Steel Pipe: ASTM A 53/A 53M, Type E, Standard Weight class. Include square-cut-grooved or threaded ends matching joining method.
- B. Galvanized-Cast-Iron Drainage Fittings: ASME B16.12, threaded.
- C. Steel Pipe Pressure Fittings:
 - 1. Galvanized-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106/A 106M, Schedule 40, seamless steel pipe. Include ends matching joining method.
 - 2. Malleable-Iron Unions: ASME B16.39; Class 150; hexagonal-stock body with ball-and-socket, metal-to-metal, bronze seating surface; and female threaded ends.
 - 3. Galvanized-Gray-Iron, Threaded Fittings: ASME B16.4, Class 125, standard pattern.
- D. Cast-Iron Flanges: ASME B16.1, Class 125.
 - 1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
 - 2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- E. Grooved-Joint, Galvanized-Steel-Pipe Appurtenances:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Anvil International; a subsidiary of Mueller Water Products, Inc.
 - b. Grinnell Mechanical Products.
 - c. Shurjoint Piping Products.
 - d. Victaulic Company.
2. Galvanized, Grooved-End Fittings for Galvanized-Steel Piping: ASTM A 536 ductile-iron castings, ASTM A 47/A 47M malleable-iron castings, ASTM A 234/A 234M forged steel fittings, or ASTM A 106/A 106M steel pipes with dimensions matching ASTM A 53/A 53M steel pipe, and complying with AWWA C606 for grooved ends.
3. Grooved Mechanical Couplings for Galvanized-Steel Piping: ASTM F 1476, Type I. Include ferrous housing sections with continuous curved keys; EPDM-rubber gasket suitable for hot and cold water; and bolts and nuts.

2.5 COPPER TUBE AND FITTINGS

- A. Copper DWV Tube: ASTM B 306, drainage tube, drawn temper.
- B. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.
- C. Hard Copper Tube: ASTM B 88, Type L and Type M, water tube, drawn temper.
- D. Soft Copper Tube: ASTM B 88, Type L, water tube, annealed temper.
- E. Copper Pressure Fittings:
 1. Copper Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
 2. Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
- F. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.
 1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
 2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- G. Solder: ASTM B 32, lead free with ASTM B 813, water-flushable flux.

2.6 ABS PIPE AND FITTINGS

- A. Solid-Wall ABS Pipe: ASTM D 2661, Schedule 40.
- B. Cellular-Core ABS Pipe: ASTM F 628, Schedule 40.
- C. ABS Socket Fittings: ASTM D 2661, made to ASTM D 3311, drain, waste, and vent patterns.

- D. Solvent Cement: ASTM D 2235.
 - 1. ABS solvent cement shall have a VOC content of 325 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2. Solvent cement shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.7 PVC PIPE AND FITTINGS **FOAM CORE PIPING NOT ALLOWED**

- A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.
- B. Cellular-Core PVC Pipe: ASTM F 891, Schedule 40.
- C. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.
- D. Adhesive Primer: ASTM F 656.
 - 1. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2. Adhesive primer shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- E. Solvent Cement: ASTM D 2564.
 - 1. PVC solvent cement shall have a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2. Solvent cement shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.8 SPECIALTY PIPE FITTINGS

- A. Transition Couplings:
 - 1. General Requirements: Fitting or device for joining piping with small differences in OD's or of different materials. Include end connections same size as and compatible with pipes to be joined.
 - 2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
 - 3. Unshielded, Nonpressure Transition Couplings:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Dallas Specialty & Mfg. Co.
 - 2) Fernco Inc.
 - 3) Mission Rubber Company; a division of MCP Industries, Inc.

- 4) Plastic Oddities; a division of Diverse Corporate Technologies, Inc.
 - b. Standard: ASTM C 1173.
 - c. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
 - d. Sleeve Materials:
 - 1) For Cast-Iron Soil Pipes: ASTM C 564, rubber.
 - 2) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
 - 3) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
4. Shielded, Nonpressure Transition Couplings:
- a. Standard: ASTM C 1460.
 - b. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
5. Pressure Transition Couplings:
- a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Cascade Waterworks Mfg. Co.
 - 2) Dresser, Inc.
 - 3) EBAA Iron, Inc.
 - 4) JCM Industries, Inc.
 - 5) Romac Industries, Inc.
 - 6) Smith-Blair, Inc.; a Sensus company.
 - 7) The Ford Meter Box Company, Inc.
 - 8) Viking Johnson.
 - b. Standard: AWWA C219.
 - c. Description: Metal, sleeve-type same size as, with pressure rating at least equal to, and ends compatible with, pipes to be joined.
 - d. Center-Sleeve Material: Manufacturer's standard.
 - e. Gasket Material: Natural or synthetic rubber.
 - f. Metal Component Finish: Corrosion-resistant coating or material.
- B. Dielectric Fittings:
- 1. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
 - 2. Dielectric Unions:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- 1) Capitol Manufacturing Company.
- 2) Central Plastics Company.
- 3) Hart Industries International, Inc.
- 4) Jomar International Ltd.
- 5) Matco-Norca, Inc.
- 6) McDonald, A. Y. Mfg. Co.
- 7) Watts Regulator Co.; a division of Watts Water Technologies, Inc.
- 8) Wilkins; a Zurn company.

b. Description:

- 1) Standard: ASSE 1079.
- 2) Pressure Rating: 150 psig.
- 3) End Connections: Solder-joint copper alloy and threaded ferrous.

3. Dielectric Flanges:

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- 1) Capitol Manufacturing Company.
- 2) Central Plastics Company.
- 3) Matco-Norca, Inc.
- 4) Watts Regulator Co.; a division of Watts Water Technologies, Inc.
- 5) Wilkins; a Zurn company.

b. Description:

- 1) Standard: ASSE 1079.
- 2) Factory-fabricated, bolted, companion-flange assembly.
- 3) Pressure Rating: 150 psig.
- 4) End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

4. Dielectric-Flange Insulating Kits:

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- 1) Advance Products & Systems, Inc.
- 2) Calpico, Inc.
- 3) Central Plastics Company.
- 4) Pipeline Seal and Insulator, Inc.

b. Description:

- 1) Nonconducting materials for field assembly of companion flanges.
- 2) Pressure Rating: 150 psig.
- 3) Gasket: Neoprene or phenolic.
- 4) Bolt Sleeves: Phenolic or polyethylene.
- 5) Washers: Phenolic with steel backing washers.

5. Dielectric Nipples:

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- 1) Elster Perfection.
- 2) Grinnell Mechanical Products.
- 3) Matco-Norca, Inc.
- 4) Precision Plumbing Products, Inc.
- 5) Victaulic Company.

b. Description:

- 1) Standard: IAPMO PS 66
- 2) Electroplated steel nipple.
- 3) Pressure Rating: 300 psig at 225 deg F.
- 4) End Connections: Male threaded or grooved.
- 5) Lining: Inert and noncorrosive, propylene.

C. \.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping to permit valve servicing.
- F. Install piping at indicated slopes.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Install piping to allow application of insulation.

- J. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- K. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
- L. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.
- M. Install soil and waste drainage and vent piping at the following minimum slopes unless otherwise indicated:
 - 1. Building Sanitary Drain: 2 percent downward in direction of flow for piping NPS 2 and smaller; 1 percent downward in direction of flow for piping NPS 3" and larger.
 - 2. Horizontal Sanitary Drainage Piping: 1 percent downward in direction of flow.
 - 3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.
- N. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
 - 1. Install encasement on underground piping according to ASTM A 674 or AWWA C105/A 21.5.
- O. Install steel piping according to applicable plumbing code.
- P. Install aboveground copper tubing according to CDA's "Copper Tube Handbook."
- Q. Install aboveground ABS piping according to ASTM D 2661.
- R. Install aboveground PVC piping according to ASTM D 2665.
- S. Install underground ABS] [and] [PVC] piping according to ASTM D 2321.
- T. Install engineered soil and waste drainage and vent piping systems as follows:
 - 1. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.
 - 2. Solvent Drainage System: Comply with ASSE 1043 and solvent fitting manufacturer's written installation instructions.
 - 3. Reduced-Size Venting: Comply with standards of authorities having jurisdiction.
- U. Plumbing Specialties:

1. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary drainage gravity-flow piping. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping. Comply with requirements for cleanouts specified in Section "Sanitary Waste Piping Specialties."
 2. Install drains in sanitary drainage gravity-flow piping. Comply with requirements for drains specified in Section "Sanitary Waste Piping Specialties."
- V. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- W. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section "Sleeves and Sleeve Seals for Plumbing Piping."
- X. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section "Sleeves and Sleeve Seals for Plumbing Piping."
- Y. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section "Escutcheons for Plumbing Piping."

3.2 JOINT CONSTRUCTION

- A. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
- B. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead-and-oakum calked joints.
- C. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.
- D. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- E. Join copper tube and fittings with soldered joints according to ASTM B 828. Use ASTM B 813, water-flushable, lead-free flux and ASTM B 32, lead-free-alloy solder.
- F. Grooved Joints: Cut groove ends of pipe according to AWWA C606. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections, over gasket, with keys seated in piping grooves. Install and tighten housing bolts.
- G. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.

- H. Plastic, Non-pressure-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 - 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
 - 2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.
 - 3. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 Appendixes.

3.3 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:

- 1. Install transition couplings at joints of piping with small differences in OD's.
- 2. In Drainage Piping: [Unshielded], non-pressure transition couplings.
 - a. NPS 1-1/2 and Smaller: Fitting-type transition couplings.
 - b. NPS 2 and Larger: Pressure transition couplings.

B. Dielectric Fittings:

- 1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- 2. Dielectric Fittings for NPS 2 and Smaller: Use dielectric unions.
- 3. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flange kits.

C. General valve installation requirements are specified in Section "Ball Valves for Plumbing Piping," Section "Butterfly Valves for Plumbing Piping," Section "Check Valves for Plumbing Piping," and Section "Gate Valves for Plumbing Piping."

D. Shutoff Valves:

- 1. Install shutoff valve on each sewage pump discharge.
- 2. Install gate or full-port ball valve for piping NPS 2 and smaller.

E. Check Valves: Install swing check valve, between pump and shutoff valve, on each sewage pump discharge.

F. Backwater Valves: Install backwater valves in piping subject to backflow.

- 1. Horizontal Piping: Horizontal backwater valves. Use normally closed type unless otherwise indicated.
- 2. Floor Drains: Drain outlet backwater valves unless drain has integral backwater valve.
- 3. Install backwater valves in accessible locations.
- 4. Comply with requirements for backwater valve specified in Section "Sanitary Waste Piping Specialties."

3.4 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for seismic-restraint devices specified in Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

- B. Comply with requirements for pipe hanger and support devices and installation specified in Section "Hangers and Supports for Plumbing Piping and Equipment."
1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
 2. Install stainless-steel pipe hangers for horizontal piping in corrosive environments.
 3. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
 4. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
 5. Vertical Piping: MSS Type 8 or Type 42, clamps.
 6. Install individual, straight, horizontal piping runs:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
 7. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 8. Base of Vertical Piping: MSS Type 52, spring hangers.
- C. Support horizontal piping and tubing within 12 inches of each fitting[, valve,] and coupling.
- D. Support vertical piping and tubing at base and at each floor.
- E. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.
- F. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
 2. NPS 3: 60 inches with 1/2-inch rod.
 3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
- G. vertical cast-iron soil piping every 15 feet.
- H. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/4: 84 inches with 3/8-inch rod.
 2. NPS 1-1/2: 108 inches with 3/8-inch rod.
 3. NPS 2: 10 feet with 3/8-inch rod.
 4. NPS 2-1/2: 11 feet with 1/2-inch rod.
 5. NPS 3: 12 feet with 1/2-inch rod.
 6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
- I. Install supports for vertical steel piping every 15 feet.
- J. Install supports for vertical stainless-steel piping every 10 feet.
- K. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/4: 72 inches with 3/8-inch rod.

2. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
 3. NPS 2-1/2: 108 inches with 1/2-inch rod.
 4. NPS 3 and NPS 5: 10 feet with 1/2-inch rod.
- L. Install supports for vertical copper tubing every 10 feet.
- M. Install hangers for ABS and PVC piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/2 and NPS 2: 48 inches with 3/8-inch rod.
 2. NPS 3: 48 inches with 1/2-inch rod.
 3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
 4. .
- N. Install supports for vertical ABS and PVC piping every 48 inches.
- O. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.5 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.
- C. Connect drainage and vent piping to the following:
1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
 2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
 3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
 4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
 5. Equipment: Connect drainage piping as indicated. Provide shutoff valve if indicated and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 and larger.
- D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.
- E. Make connections according to the following unless otherwise indicated:
1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
 2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.6 IDENTIFICATION

- A. Identify exposed sanitary waste and vent piping. Comply with requirements for identification specified in Section "Identification for Plumbing Piping and Equipment."

3.7 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
 - 1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 - 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
 - 1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 - 2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - 3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping except outside leaders on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
 - 4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.
 - 5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 - 6. Prepare reports for tests and required corrective action.
 - 7. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - 8. Cap and subject piping to static-water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and

allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.

9. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
10. Prepare reports for tests and required corrective action.

3.8 CLEANING AND PROTECTION

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.
- D. Exposed ABS and PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.

3.9 PIPING SCHEDULE

- A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.
- B. Aboveground, soil and waste piping NPS 4 and smaller shall be[any of] the following:
 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 2. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.
 3. Copper DWV tube, copper drainage fittings, and soldered joints.
 4. Solid-wall ABS pipe, ABS socket fittings, and solvent-cemented joints.
 5. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 6. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.
- C. Aboveground, vent piping NPS 4 and smaller shall be[**any of**] the following:
 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 2. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.
 3. Copper DWV tube, copper drainage fittings, and soldered joints.
 - a. Option for Vent Piping, NPS 2-1/2 and NPS 3-1/2: Hard copper tube, Type M; copper pressure fittings; and soldered joints.
 4. Solid-wall ABS pipe, ABS socket fittings, and solvent-cemented joints.
 5. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 6. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.
- D. Underground, soil, waste, and vent piping NPS 4 and smaller shall be any of the following:
 1. Service class, cast-iron soil piping; gaskets; and gasketed joints.

2. Hubless, cast-iron soil pipe and fittings; CISPI] hubless-piping couplings; and coupled joints.
 3. Solid wall ABS pipe, ABS socket fittings, and solvent-cemented joints.
 4. Solid wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 5. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.
- E. Underground, soil and waste piping NPS 5 and larger shall be any of] the following:
1. Service class, cast-iron soil piping; gaskets; and gasketed joints.
 2. Hubless, cast-iron soil pipe and fittings; CISPI or heavy-duty hubless-piping couplings; coupled joints.
 3. Solid-wall PVC pipe; PVC socket fittings; and solvent-cemented joints.
 4. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

END OF SECTION 221316

SECTION 221319 - SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 1. Cleanouts.
 2. Floor drains.
 3. Air-admittance valves.
 4. Roof flashing assemblies.
 5. Through-penetration firestop assemblies.
 6. Miscellaneous sanitary drainage piping specialties.
 7. Flashing materials.

1.3 INFORMATIONAL SUBMITTALS

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
 - b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

- B. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For drainage piping specialties to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic sanitary piping specialty components.

1.6 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Section "Cast-in-Place Concrete." or Section "Miscellaneous Cast-in-Place Concrete."
- B. Coordinate size and location of roof penetrations.

PART 2 - PRODUCTS

2.1 CLEANOUTS

- A. Exposed Metal Cleanouts:
 - 1. ASME A112.36.2M, Cast-Iron Cleanouts:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Josam Company.
 - 2) MIFAB, Inc.
 - 3) Smith, Jay R. Mfg. Co.
 - 4) Tyler Pipe.
 - 5) Watts Drainage Products.
 - 6) Zurn Plumbing Products Group.
 - 2. than one size smaller than cleanout size.
 - 3. Closure: Stainless-steel plug with seal.
- B. Metal Floor Cleanouts:
 - 1. ASME A112.36.2M, Cast-Iron Cleanouts:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Josam Company.
 - 2) Oatey.

- 3) Sioux Chief Manufacturing Co., Inc.
- 4) Smith, Jay R. Mfg. Co.
- 5) Tyler Pipe.
- 6) Watts Drainage Products.
- 7) Zurn Plumbing Products Group.

C. Plastic Floor Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Canplas LLC.
 - b. IPS Corporation.
 - c. NDS Inc.
 - d. Plastic Oddities.
 - e. Sioux Chief Manufacturing Company, Inc.
 - f. Zurn Plumbing Products Group; Light Commercial Operation.
2. Size: Same as connected branch.
3. Body: PVC.
4. Closure Plug: PVC.
5. Riser: Drainage pipe fitting and riser to cleanout of same material as drainage piping.

2.2 FLOOR DRAINS

A. Cast-Iron Floor Drains:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Commercial Enameling Co.
 - b. Josam Company; Josam Div.
 - c. MIFAB, Inc.
 - d. Prier Products, Inc.
 - e. Smith, Jay R. Mfg. Co.
 - f. Tyler Pipe; Wade Div.
 - g. Watts Drainage Products.
 - h. Zurn Plumbing Products Group; light Commercial Operation
2. Pattern: Floor drain.
3. Body Material: Gray iron.
4. Seepage Flange: Not required.
5. Anchor Flange: [not required.
6. Clamping Device: Not required.
7. Outlet: Bottom.
8. .
9. Sediment Bucket: Not required.
10. Top or Strainer Material: Nickel bronze.
11. Top of Body and Strainer Finish: Nickel bronze.
12. Top Shape: Square.
13. Top Loading Classification: Medium Duty.

14. Funnel: Required.
15. Inlet Fitting: Not required.
16. Trap Material: Cast iron.
17. Trap Pattern: Standard P-trap.

B. Stainless-Steel Floor Drains:

1. ASME A112.3.1, Stainless-Steel Floor Drains:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Josam Company.
 - 2) Smith J.R.
 - 3) Zurn manufacturer

2.3 ..AIR-ADMITTANCE VALVES

A. Fixture Air-Admittance Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Ayrlett, LLC.
 - b. Durgo, Inc.
 - c. Oatey.
 - d. ProSet Systems Inc.
 - e. RectorSeal.
 - f. Studor, Inc.
2. Standard: ASSE 1051, Type A for single fixture or Type B for branch piping.
3. Housing: Plastic.
4. Operation: Mechanical sealing diaphragm.
5. Size: Same as connected fixture or branch vent piping.

B. Stack Air-Admittance Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Durgo, Inc.
 - b. Oatey.
 - c. Studor, Inc.
2. Standard: ASSE 1050 for vent stacks.
3. Housing: Plastic.
4. Operation: Mechanical sealing diaphragm.
5. Size: Same as connected stack vent or vent stack.
6. ROOF FLASHING ASSEMBLIES

C. Roof Flashing Assemblies:

1. Description: Manufactured assembly made of 4.0-lb/sq. ft., 0.0625-inch-] thick, lead flashing collar and skirt extending at least from pipe, with galvanized-steel boot reinforcement and counterflashing fitting.
 - a. Open-Top Vent Cap: Without cap.
 - b. Low-Silhouette Vent Cap: With vandal-proof vent cap.
 - c. Extended Vent Cap: With field-installed, vandal-proof vent cap.

2.4 THROUGH-PENETRATION FIRESTOP ASSEMBLIES

A. Through-Penetration Firestop Assemblies:

1. Standard: UL 1479 assembly of sleeve and stack fitting with firestopping plug.
2. Size: Same as connected soil, waste, or vent stack.
3. Sleeve: Molded PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.
4. Stack Fitting: ASTM A 48/A 48M, gray-iron, hubless-pattern, wye branch with neoprene O-ring at base and gray-iron plug in thermal-release harness. Include PVC protective cap for plug.
5. Special Coating: Corrosion resistant on interior of fittings.

2.5 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Open Drains:

1. Description: Shop or field fabricate from ASTM A 74, Service class, hub-and-spigot, cast-iron, soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting joined with ASTM C 564, rubber gaskets.
2. Size: Same as connected waste piping

B. Deep-Seal Traps:

1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
2. Size: Same as connected waste piping.
 - a. NPS 2: 4-inch- minimum water seal.
 - b. NPS 2-1/2 and Larger: 5-inch- minimum water seal.

C. Air-Gap Fittings:

1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
2. Body: Bronze or cast iron.
3. Inlet: Opening in top of body.
4. Outlet: Larger than inlet.

5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.

D. Sleeve Flashing Device:

1. Description: Manufactured, cast-iron fitting, with clamping device, that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend 1 inch] above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.
2. Size: As required for close fit to riser or stack piping.

E. Stack Flashing Fittings:

1. Description: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.
2. Size: Same as connected stack vent or vent stack.

F. Vent Caps:

1. Description: Cast-iron body with threaded or hub inlet and vandal-proof design. Include vented hood and setscrews to secure to vent pipe.
2. Size: Same as connected stack vent or vent stack.

G. Frost-Resistant Vent Terminals:

1. Description: Manufactured or shop-fabricated assembly constructed of copper, lead-coated copper, or galvanized steel.
2. Design: To provide 1-inch enclosed air space between outside of pipe and inside of flashing collar extension, with counterflashing.

H. Expansion Joints:

1. Standard: ASME A112.21.2M.
2. Body: Cast iron with bronze sleeve, packing, and gland.
3. End Connections: Matching connected piping.
4. Size: Same as connected soil, waste, or vent piping.

2.6 FLASHING MATERIALS

A. Lead Sheet: ASTM B 749, Type L51121, copper bearing, with the following minimum weights and thicknesses, unless otherwise indicated:

1. General Use: 4.0-lb/sq. ft., 0.0625-inch thickness.
2. Vent Pipe Flashing: 3.0-lb/sq. ft., 0.0469-inch thickness.
3. Burning: 6-lb/sq. ft., 0.0938-inch thickness.

B. Copper Sheet: ASTM B 152/B 152M, of the following minimum weights and thicknesses, unless otherwise indicated:

1. General Applications: 12 oz./sq. ft..
2. Vent Pipe Flashing: 8 oz./sq. ft..

- C. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch minimum thickness, unless otherwise indicated. Include G90 hot-dip galvanized, mill-phosphatized finish for painting if indicated.
- D. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil minimum thickness.
- E. Fasteners: Metal compatible with material and substrate being fastened.
- F. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.
- G. Solder: ASTM B 32, lead-free alloy.
- H. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
 - 1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
 - 2. Locate at each change in direction of piping greater than 45 degrees.
 - 3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
 - 4. Locate at base of each vertical soil and waste stack.
- B. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- C. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- D. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
 - 1. Position floor drains for easy access and maintenance.
 - 2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:
 - a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
 - b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
 - c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.

3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
 4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.
- E. Assemble and install ASME A112.3.1, stainless-steel channel drainage systems according to ASME A112.3.1. Install on support devices so that top will be flush with surface.
 - F. Assemble non-ASME A112.3.1, stainless-steel channel drainage system components according to manufacturer's written instructions. Install on support devices so that top will be flush with adjacent surface.
 - G. Assemble FRP channel drainage system components according to manufacturer's written instructions. Install on support devices so that top will be flush with adjacent surface.
 - H. Assemble plastic channel drainage system components according to manufacturer's written instructions. Install on support devices so that top will be flush with adjacent surface.
 - I. Install fixture air-admittance valves on fixture drain piping.
 - J. Install stack air-admittance valves at top of stack vent and vent stack piping.
 - K. Install air-admittance-valve wall boxes recessed in wall.
 - L. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.
 - M. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof.
 - N. Install through-penetration firestop assemblies in plastic conductors] and stacks at floor penetrations.
 - O. Assemble open drain fittings and install with top of hub 1 inch] above floor.
 1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
 2. Size: Same as floor drain inlet.
 - P. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.
 - Q. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.
 - R. Install vent caps on each vent pipe passing through roof.
 - S. Install frost-resistant vent terminals on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.
 - T. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.
 - U. Install frost-proof vent caps on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.

- V. Install wood-blocking reinforcement for wall-mounting-type specialties.
- W. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

3.2 CONNECTIONS

- A. Comply with requirements in Section "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.
- C. FOG Disposal Systems: Connect inlet and outlet to unit, connect flow-control fitting and fresh-air inlet piping to unit inlet piping, and connect vent piping between trap and media chamber. Connect electrical power.
- D. Ground equipment according to Section "Grounding and Bonding for Electrical Systems."
- E. Connect wiring according to Section "Low-Voltage Electrical Power Conductors and Cables."

3.3 FLASHING INSTALLATION

- A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:
 - 1. Lead Sheets: Burn joints of lead sheets 6.0-lb/sq. ft., 0.0938-inch thickness or thicker. Solder joints of lead sheets 4.0-lb/sq. ft., 0.0625-inch thickness or thinner.
 - 2. Copper Sheets: Solder joints of copper sheets.
- B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
 - 1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.
 - 2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
 - 3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.
- C. Set flashing on floors and roofs in solid coating of bituminous cement.
- D. Secure flashing into sleeve and specialty clamping ring or device.
- E. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Section "Sheet Metal Flashing and Trim."
- F. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.
- G. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.4 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 221319

SECTION 221329

SUBMERSIBLE DRAIN PUMP STATION & ACCESSORIES

1.0 SCOPE:

Under this heading shall be included the furnishing, testing and adjustment submersible type pumps as specified and as shown on the drawings. The submersible pumps for the drain pump station include two (2) 5.5 hp pumps.

2.0 GENERAL:

Each pump shall be suitable for service in raw, unscreened sewage with 3-inch solids and shall conform to the requirements shown on the Drawings and in the Specifications for flow rate, total dynamic head, horsepower, voltage and phase. Pumps shall be manufactured by Grundfos, ABS or engineer approved equal.

Plant Drain Lift Station Pumps:

DRAIN PUMPS - DESIGN REQUIREMENTS	
Item	Design Conditions
Maximum Pump Design Speed (rpm)	1762
Discharge Size (inches)	4
Maximum Pump Shut-off Head at Design Speed (feet)	55
Maximum Motor Horsepower	5.5
Design TDH (feet)	33
Minimum Capacity at Design TDH (gpm)	300
Minimum Pump Efficiency at Design TDH (%)	62%
Static Head (feet)	16

Shop drawings shall be submitted indicating anticipated performance curves of the following:

1. Capacity vs head curves.
2. Brake horsepower curves.
3. Hydraulic efficiency curves.
4. Motor input KW curves.
5. Certified motor data curves.

Each curve shall cover full range of operation from shutoff to maximum capacity.

Shop drawings shall show the principal dimensions of the pump assembly, including the size of suction and discharge and details of discharge connection, guide bars, guide brackets, shaft seals, lubrication system, motor and casing, and power cable attachment. Shop drawings shall be specifically detailed for this project and shall indicate elevations for all necessary controls and wetwell elevations such as top, invert, bottom water levels etc.

3.0 PUMP DESIGN:

The design of the pumps shall be such that the pump unit will be automatically and firmly connected to the discharge piping when lowered into place on its mating discharge connection. The pumps shall be easily removable for inspection or service, requiring no bolts, nuts or other fastenings to be disconnected. For this purpose, there shall be no need for personnel to enter the wetwell. The pumps and their appurtenances shall be capable of continuous submergence under water operation without loss of watertight integrity to a depth of 65 feet.

4.0 PUMP CONSTRUCTION:

The pump casing, impeller, motor housing and stationary base elbow shall be manufactured of close-grained cast iron, ASTM A48, Class 35B with smooth surfaces devoid of porosity or other irregularities All exposed nuts or bolts shall be AISI type 316 stainless steel construction. All metal surfaces coming into contact with the pumpage, other than stainless steel or brass, shall be protected by a factory applied spray coating of acrylic dispersion zinc phosphate primer with a polyester resin paint finish on the exterior of the pump.

Sealing design for the pump/motor assembly shall incorporate machined surfaces fitted with Nitrile (Buna-N) rubber O-rings or Viton. Sealing will be the result of controlled compression of rubber O-rings in two planes of the sealing interface. Housing interfaces shall meet with metal-to-metal contact between machined surfaces, and sealing shall be accomplished without requiring a specific torque on the securing fasteners. Rectangular cross sectioned gaskets requiring specific torque limits to achieve compression shall not be considered equal. No secondary sealing compounds shall be required or used.

Sealing design for the pump/motor assembly shall incorporate machined surfaces fitted with Nitrile or Viton rubber O-rings. Sealing will be the result of controlled compression of rubber O-rings in two planes of the sealing interface. Housing interfaces shall meet with metal-to-metal contact between machined surfaces, and sealing shall be accomplished without requiring a specific torque on the securing fasteners. Rectangular cross sectioned gaskets requiring specific torque limits to

achieve compression shall not be considered equal. No secondary sealing compounds shall be required or used.

The impeller shall be of the semi-open, non-clogging, single-vane design. The impeller shall be capable of passing a minimum of 3.0 inch spherical solids. The impeller shall have a slip fit connection onto the motor shaft, driven by a shaft key, and shall be securely fastened to the shaft by a stainless steel screw. A positively engaged, ratcheting washer assembly shall prevent the screw from loosening. The head of the impeller screw shall be effectively recessed within the impeller bore to prevent disruption of the flow stream and loss of hydraulic efficiency. The impeller shall be dynamically balanced to the ISO 10816 standard to provide smooth, vibration-free operation.

The pump shall include a Self-Cleaning cast iron wear plate system. The wear plate shall be designed with inlet incorporating cutting grooves as well as an outward spiral V-shaped groove on the side facing the impeller. The wear plate shall be factory mounted to the volute in a fixed position with metal-to-metal contact on machined surfaces to insure optimal clearance and efficiency at startup. The operator shall be able to easily restore the factory set impeller clearance and maintain peak pumping efficiency. The operator shall be able to perform the adjustment at the pump station site, quickly and easily without dismantling the pump and without the use of special tools. The suction flange shall be integrated into the wear plate.

Pumps that do not have an integral adjustable cast iron wear plate system and/or pumps that require replaceable wear rings are not acceptable.

Pump Volute: The pump volute shall be a single-piece, gray cast iron, EN-GJL-250 (ASTM A-48, Class 35B), non-concentric design with centerline discharge. Passages shall be smooth and large enough to pass any solids which may enter through the impeller. The discharge size shall be 4 inches. The discharge flange design shall permit attachment to standard ANSI and DIN flanges/appurtenances. The discharge flange shall be radially slotted to accept both 4 inch ANSI class 125/150 and metric DN150 flanged fittings. Proprietary or nonstandard flange dimensions shall not be considered acceptable. The minimum working pressure of the volute and pump assembly shall be 16 bar (232 psi).

The pump casing shall be of the semi-concentric volute design, of one piece construction, having centerline discharge to minimize clogging or flow interference, and to provide the proper weight distribution for use with the pump guide system.

The pump shall include a Smart-Trim adjustable cast iron wear plate system. The suction clearance between the impeller and the pump casing wear plate shall be fully

adjustable through external adjustment hardware. The operator shall be able to easily restore the factory set impeller clearance and maintain peak pumping efficiency. The operator shall be able to perform the adjustment at the pump station site, quickly and easily without dismantling the pump and without the use of special tools.

Pumps that do not have an integral adjustable cast iron wear plate system and/or pumps that require replaceable wear rings are not acceptable.

All external casting surfaces of the pump/motor coming into contact with the pumped liquid shall have a surface cleanliness equal to that of a SSPE-SP6 process prior to being factory protected by one (1) coat of an environmentally safe machinery enamel coating with a high solids content.

All external hardware including name plates on the pump/motor shall be 300 stainless steel.

5.0 ACCESS FRAME AND GUIDES:

An access frame complete with hinged and hasps-equipped covers, upper guide holder and level sensor cable holder shall be included. Each door shall have a safety handle to maintain the door in the open position. Doors shall be of checkered aluminum plate. Cover guide bar holders shall be integral with the discharge connection. The guide bars shall not support any portion of the weight of the pump.

6.0 LIQUID LEVEL SENSORS:

A. Submersible Pressure Transducer

Liquid level sensors shall consist of an analog wet well level pressure transducer capable of measuring the wet well level and producing a 4-20mA or 0.5 to 4.5 VDC signal for the controller. Provide a Blue Ribbon Model 01 Birdcage Series submersible pressure transducer or approved equal.

The submersible pressure transducer shall be installed inside a stilling well, constructed out of appropriately sized PVC pipe. The PVC stilling well pipe shall be fastened to the wet well wall every 6 feet with stainless steel fasteners. The lower end of the stilling well pipe shall be exactly 6-inches off of the wet well floor. The installing contractor shall coordinate the location of the stilling well with the pump and control equipment supplier.

B. Emergency Float Switch Control System

Provide a four (4) float system to provide a back-up/ secondary level sensing/control. The emergency float system will be enabled if

1. Submersible Level Transducer Fault is detected.
2. High Water Alarm/ Back-Up Float is activated during automatic operation
3. Operator selects Emergency Float Switch Control System.

7.0 CONTROLS:

Furnish and install one automatic pump control center in NEMA 4X Enclosure for 460 volt, 3-phase service. For each pump there shall be included individual disconnect switches, magnetic contactors, hand-off automatic selector switches, running lights, ammeters and elapsed time meters. An alarm system consisting of an alarm light and horn, with silencing switch shall be provided. A 24-volt control circuit transformer with disconnect and overload protection shall be provided. A duplex weatherproof convenience outlet shall be provided. Terminal strips shall be provided for interface wiring between control panel and pumping station. The controls shall automatically alternate the operation of the pumps. See Division 16000 for additional requirements.

8.0 CHECK VALVES:

Check valves shall be of the tight closing, rubber-seated type. No metal seating surfaces shall be permitted. Valves shall be complete with outside lever and weight.

Valve bodies and covers shall be constructed of cast iron, ASTM A126, Class B, with body wall thickness designed for 250 psi water working pressure.

Valve discs shall be constructed of cast iron ASTM A126, Class B, and attached to the hinge shaft by means of a disc center pin permitting axial movement only. Disc oscillation shall be compensated for by providing a configuration having a convex surface opposing the direction of flow.

Hinge shafts shall be constructed of nominal diameter stainless steel 18-8, Type 316, and shall conform to the following minimum diameters and weights:

<u>Valve Size</u>	<u>Valve Weight</u>	<u>Shaft Diameter</u>
4"	154#	3/4"
6"	234#	1"
8"	310#	1-1/4"
10"	485#	1-1/4"
12"	970#	1-1/2"
14"	1481#	2"

16"	1858#	2"
18"	2390#	2"

The body seat ring shall be constructed of Bronze, ASTM B62 and shall be mechanically retained by means of roll pins or stainless steel cap screws. The resilient rubber seat shall be 80 durometer and securely attached to the valve disc with bronze seat ring and cap screws.

9.0 PUMP TEST:

Each pump shall be factory tested at various heads and efficiency. Certified curves shall be submitted to the Engineer.

The pump manufacturer shall perform the following inspections and tests on each pump before shipment from factory and shall certify that each has been performed.

- a) Impeller, motor rating and electrical connections shall first be checked and certified to be in compliance with the Contract Documents.
- b) A motor cable insulation test for moisture content or insulation defects shall be made.
- c) Prior to submergence, the pump shall be run dry to establish correct rotation and mechanical integrity.
- d) The pump shall be run for 60 minutes submerged a minimum of six feet under water.
- e) After operational test d), the insulation test b) is to be performed again.

The pump cable end shall be sealed with a protective covering to make it impervious to moisture or water seepage prior to electrical installation.

10.0 FACTORY PUMP TESTS:

Pumps shall be tested at the factory. Pumps shall be tested at actual drive motor speed.

Factory tests of the pumping equipment shall be made in accordance with the Test Code of Hydraulic Institute Standards and test curves for each pump shall have the capacity plotted as abscissas, and the operating head, brake horsepower, and efficiency plotted as ordinates. Test curves shall cover the full range of operation from shut-off to maximum capacity. The characteristics of the pumps shall conform with this Specification.

All pumping equipment which fails to meet the requirements of the Test Code shall be removed and shall be replaced with pumping equipment which meet the Specifications requirements. Five notarized copies of certified factory performance test curves for each pump shall be furnished and approved before shipment of the pumps to the site.

11.0 FIELD TESTS, ADJUSTMENT AND START-UP:

After completion of installation, each pumping unit and all related equipment shall be inspected and approved by a representative of the manufacturer as being in compliance with the manufacturer's recommendations and requirements. After such inspection, the equipment shall be tested by the manufacturer's representative in the presence of the Owner and Engineer. Each pump shall meet the performance requirements.

Field test results stated in Paragraph 3 within minus one percent and plus five percent tolerance shall be certified by the pump manufacturer after field testing to be in conformance with the Contract Specifications. Pumps not meeting these requirements shall be replaced.

Alignment of each pump unit shall be checked after installation of pump and piping to determine that the base is not distorted and pipe strain is not present.

12.0 PUMP WARRANTY:

The pump manufacturer shall warrant the pumps in writing against defects in workmanship and material for a period of five years or 10,000 hours of normal use, operation and service. The warranty shall be in printed form and apply to all similar units.

The manufacturer shall furnish six sets of its Submittal Drawings, Operation and Maintenance Instruction Manuals and parts List.

13.0 SPARE PARTS:

The manufacturer shall supply to the Owner the following spare parts:

- a) One impeller.
- b) Forty feet of lifting chain.
- c) One stator.
- d) One rotor.
- e) Upper and lower bearings for one pump.

14.0 MEASUREMENT AND PAYMENT:

Measurement and payment for work included in this Section of the Specifications shall be by lump sum in accordance with Section 01150, Measurement and Payment.

15.0 PACKAGE PUMP STATION DESIGN:

Pump station design shall adhere to the following design criteria.

Elevations:

Top of Wetwell: 823'

Gravity invert elevations:

- Invert for solids handling building drainage: 817.00'
- Invert for aerobic digester decant line: 815.50'

High water alarm: 814.50'

Lag pump on: 814.00'

Lead pump on: 813.50'

All pumps off: 810.50'

Low water level: 810.00'

Minimum pump WL: 21"

The package pump station shall include an associated valve vault, wetwell, and control panel. The valve vault shall be designed in accordance with the manufacturer's recommendations/details.

--- END OF SECTION ---

SECTION 221329 B

SUBMERSIBLE DRAIN AND SCUM PUMP AND ACCESSORIES

1.0 SCOPE:

Under this heading shall be included the furnishing, testing and adjustment submersible type pumps as specified and as shown on the drawings. Submersible pumps include two (2) 12 hp pumps for drain lift station and two (2) 3 hp pumps for scum lift station.

2.0 GENERAL:

Each pump shall be suitable for service in raw, unscreened sewage with 3 inch solids and shall conform to the requirements shown on the Drawings and in the Specifications for flow rate, total dynamic head, horse power, voltage and phase. Pumps shall be as manufactured by ABS or engineer approved equal.

Plant Drain Lift Station Pumps:

DRAIN PUMPS - DESIGN REQUIREMENTS	
Item	Design Conditions
Maximum Pump Design Speed (rpm)	1800
Discharge Size (inches)	6
Maximum Pump Shut-off Head at Design Speed (feet)	79
Maximum Motor Horsepower	12
Design TDH (feet)	41
Minimum Capacity at Design TDH (gpm)	822
Minimum Pump Efficiency at Design TDH (%)	74%
Static Head (feet)	36

Scum Lift Station Pumps:

SCUM PUMPS - DESIGN REQUIREMENTS	
Item	Design Conditions
Maximum Pump Design Speed (rpm)	1800
Discharge Size (inches)	3
Maximum Pump Shut-off Head at Design Speed (feet)	43
Maximum Motor Horsepower	3
Design TDH (feet)	33
Minimum Capacity at Design TDH (gpm)	177

Minimum Pump Efficiency at Design TDH (%)	52%
Static Head (feet)	29

Shop drawings shall be submitted indicating anticipated performance curves of the following:

1. Capacity vs head curves.
2. Brake horsepower curves.
3. Hydraulic efficiency curves.
4. Motor input KW curves.
5. Certified motor data curves.

Each curve shall cover full range of operation from shutoff to maximum capacity.

Shop drawings shall show the principal dimensions of the pump assembly, including the size of suction and discharge and details of discharge connection, guide bars, guide brackets, shaft seals, lubrication system, motor and casing, and power cable attachment. Shop drawings shall be specifically detailed for this project.

3.0 PUMP DESIGN:

The design of the pumps shall be such that the pump unit will be automatically and firmly connected to the discharge piping when lowered into place on its mating discharge connection. The pumps shall be easily removable for inspection or service, requiring no bolts, nuts or other fastenings to be disconnected. For this purpose, there shall be no need for personnel to enter the wetwell. The pumps and their appurtenances shall be capable of continuous submergence under water operation without loss of watertight integrity to a depth of 65 feet.

4.0 PUMP CONSTRUCTION:

The pump casing, impeller, motor housing and stationary base elbow shall be manufactured of close-grained cast iron, ASTM A48, Class 35B with smooth surfaces devoid of porosity or other irregularities All exposed nuts or bolts shall be AISI type 316 stainless steel construction. All metal surfaces coming into contact with the pumpage, other than stainless steel or brass, shall be protected by a factory applied spray coating of acrylic dispersion zinc phosphate primer with a polyester resin paint finish on the exterior of the pump.

Sealing design for the pump/motor assembly shall incorporate machined surfaces fitted with Nitrile (Buna-N) rubber O-rings or Viton. Sealing will be the result of controlled compression of rubber O-rings in two planes of the sealing interface. Housing

interfaces shall meet with metal-to-metal contact between machined surfaces, and sealing shall be accomplished without requiring a specific torque on the securing fasteners. Rectangular cross sectioned gaskets requiring specific torque limits to achieve compression shall not be considered equal. No secondary sealing compounds shall be required or used.

Sealing design for the pump/motor assembly shall incorporate machined surfaces fitted with Nitrile or Viton rubber O-rings. Sealing will be the result of controlled compression of rubber O-rings in two planes of the sealing interface. Housing interfaces shall meet with metal-to-metal contact between machined surfaces, and sealing shall be accomplished without requiring a specific torque on the securing fasteners. Rectangular cross sectioned gaskets requiring specific torque limits to achieve compression shall not be considered equal. No secondary sealing compounds shall be required or used.

The impeller shall be of the semi-open, non-clogging, single-vane design. The impeller shall be capable of passing a minimum of 3.0 inch spherical solids. The impeller shall have a slip fit connection onto the motor shaft, driven by a shaft key, and shall be securely fastened to the shaft by a stainless steel screw. A positively engaged, ratcheting washer assembly shall prevent the screw from loosening. The head of the impeller screw shall be effectively recessed within the impeller bore to prevent disruption of the flow stream and loss of hydraulic efficiency. The impeller shall be dynamically balanced to the ISO 10816 standard to provide smooth, vibration-free operation.

The pump shall include a Self-Cleaning cast iron wear plate system. The wear plate shall be designed with inlet incorporating cutting grooves as well as an outward spiral V-shaped groove on the side facing the impeller. The wear plate shall be factory mounted to the volute in a fixed position with metal-to-metal contact on machined surfaces to insure optimal clearance and efficiency at startup. The operator shall be able to easily restore the factory set impeller clearance and maintain peak pumping efficiency. The operator shall be able to perform the adjustment at the pump station site, quickly and easily without dismantling the pump and without the use of special tools. The suction flange shall be integrated into the wear plate.

Pumps that do not have an integral adjustable cast iron wear plate system and/or pumps that require replaceable wear rings are not acceptable.

Pump Volute: The pump volute shall be a single-piece, gray cast iron, EN-GJL-250 (ASTM A-48, Class 35B), non-concentric design with centerline discharge. Passages shall be smooth and large enough to pass any solids which may enter through the impeller. The discharge size shall be 6 inches. The discharge flange design shall permit attachment to standard ANSI and DIN flanges/appurtenances. The discharge flange shall be radially slotted to accept both 6

inch ANSI class 125/150 and metric DN150 flanged fittings. Proprietary or nonstandard flange dimensions shall not be considered acceptable. The minimum working pressure of the volute and pump assembly shall be 16 bar (232 psi).

The pump casing shall be of the semi-concentric volute design, of one piece construction, having centerline discharge to minimize clogging or flow interference, and to provide the proper weight distribution for use with the pump guide system.

The pump shall include a Smart-Trim adjustable cast iron wear plate system. The suction clearance between the impeller and the pump casing wear plate shall be fully adjustable through external adjustment hardware. The operator shall be able to easily restore the factory set impeller clearance and maintain peak pumping efficiency. The operator shall be able to perform the adjustment at the pump station site, quickly and easily without dismantling the pump and without the use of special tools.

Pumps that do not have an integral adjustable cast iron wear plate system and/or pumps that require replaceable wear rings are not acceptable.

All external casting surfaces of the pump/motor coming into contact with the pumped liquid shall have a surface cleanliness equal to that of a SSPE-SP6 process prior to being factory protected by one (1) coat of an environmentally-safe machinery enamel coating with a high solids content.

All external hardware including name plates on the pump/motor shall be 300 stainless steel.

5.0 ACCESS FRAME AND GUIDES:

An access frame complete with hinged and hasps-equipped covers, upper guide holder and level sensor cable holder shall be included. Each door shall have a safety handle to maintain the door in the open position. Doors shall be of checkered aluminum plate. Cover guide bar holders shall be integral with the discharge connection. The guide bars shall not support any portion of the weight of the pump.

6.0 LIQUID LEVEL SENSORS:

A. Submersible Pressure Transducer

Liquid level sensors shall consist of an analog wet well level pressure transducer capable of measuring the wet well level and producing a 4-20mA or 0.5 to 4.5 VDC

signal for the controller. Provide a Blue Ribbon Model 01 Birdcage Series submersible pressure transducer or approved equal.

The submersible pressure transducer shall be installed inside a stilling well, constructed out of appropriately sized PVC pipe. The PVC stilling well pipe shall be fastened to the wet well wall every 6 feet with stainless steel fasteners. The lower end of the stilling well pipe shall be exactly 6-inches off of the wet well floor. The installing contractor shall coordinate the location of the stilling well with the pump and control equipment supplier.

B. Emergency Float Switch Control System

Provide a four (4) float system to provide a back-up/ secondary level sensing/control. The emergency float system will be enabled if

1. Submersible Level Transducer Fault is detected.
2. High Water Alarm/ Back-Up Float is activated during automatic operation
3. Operator selects Emergency Float Switch Control System.

7.0 CONTROLS:

Furnish and install one automatic pump control center in NEMA 4X Enclosure for 460 volt, 3-phase service. For each pump there shall be included individual disconnect switches, magnetic contactors, hand-off automatic selector switches, running lights, ammeters and elapsed time meters. An alarm system consisting of an alarm light and horn, with silencing switch shall be provided. A 24-volt control circuit transformer with disconnect and overload protection shall be provided. A duplex weatherproof convenience outlet shall be provided. Terminal strips shall be provided for interface wiring between control panel and pumping station. The controls shall automatically alternate the operation of the pumps. See Division 16000 for additional requirements.

8.0 CHECK VALVES:

Check valves shall be of the tight closing, rubber-seated type. No metal seating surfaces shall be permitted. Valves shall be complete with outside lever and weight.

Valve bodies and covers shall be constructed of cast iron, ASTM A126, Class B, with body wall thickness designed for 250 psi water working pressure.

Valve discs shall be constructed of cast iron ASTM A126, Class B, and attached to the hinge shaft by means of a disc center pin permitting axial movement only. Disc oscillation shall be compensated for by providing a configuration having a convex surface opposing the direction of flow.

Hinge shafts shall be constructed of nominal diameter stainless steel 18-8, Type 316, and shall conform to the following minimum diameters and weights:

<u>Valve Size</u>	<u>Valve Weight</u>	<u>Shaft Diameter</u>
4"	154#	3/4"
6"	234#	1"
8"	310#	1-1/4"
10"	485#	1-1/4"
12"	970#	1-1/2"
14"	1481#	2"
16"	1858#	2"
18"	2390#	2"

The body seat ring shall be constructed of Bronze, ASTM B62 and shall be mechanically retained by means of roll pins or stainless steel cap screws. The resilient rubber seat shall be 80 durometer and securely attached to the valve disc with bronze seat ring and cap screws.

9.0 PUMP TEST:

Each pump shall be factory tested at various heads and efficiency. Certified curves shall be submitted to the Engineer.

The pump manufacturer shall perform the following inspections and tests on each pump before shipment from factory and shall certify that each has been performed.

- a) Impeller, motor rating and electrical connections shall first be checked and certified to be in compliance with the Contract Documents.
- b) A motor cable insulation test for moisture content or insulation defects shall be made.
- c) Prior to submergence, the pump shall be run dry to establish correct rotation and mechanical integrity.
- d) The pump shall be run for 60 minutes submerged a minimum of six feet under water.
- e) After operational test d), the insulation test b) is to be performed again.

The pump cable end shall be sealed with a protective covering to make it impervious to moisture or water seepage prior to electrical installation.

10.0 FACTORY PUMP TESTS:

Pumps shall be tested at the factory. Pumps shall be tested at actual drive motor speed.

Factory tests of the pumping equipment shall be made in accordance with the Test Code of Hydraulic Institute Standards and test curves for each pump shall have the capacity plotted as abscissas, and the operating head, brake horsepower, and efficiency plotted as ordinates. Test curves shall cover the full range of operation from shut-off to maximum capacity. The characteristics of the pumps shall conform with this Specification.

All pumping equipment which fails to meet the requirements of the Test Code shall be removed and shall be replaced with pumping equipment which meet the Specifications requirements. Five notarized copies of certified factory performance test curves for each pump shall be furnished and approved before shipment of the pumps to the site.

11.0 FIELD TESTS, ADJUSTMENT AND START-UP:

After completion of installation, each pumping unit and all related equipment shall be inspected and approved by a representative of the manufacturer as being in compliance with the manufacturer's recommendations and requirements. After such inspection, the equipment shall be tested by the manufacturer's representative in the presence of the Owner and Engineer. Each pump shall meet the performance requirements.

Field test results stated in Paragraph 3 within minus one percent and plus five percent tolerance shall be certified by the pump manufacturer after field testing to be in conformance with the Contract Specifications. Pumps not meeting these requirements shall be replaced.

Alignment of each pump unit shall be checked after installation of pump and piping to determine that the base is not distorted and pipe strain is not present.

12.0 PUMP WARRANTY:

The pump manufacturer shall warrant the pumps in writing against defects in workmanship and material for a period of five years or 10,000 hours of normal use, operation and service. The warranty shall be in printed form and apply to all similar units.

The manufacturer shall furnish six sets of its Submittal Drawings, Operation and Maintenance Instruction Manuals and parts List.

13.0 SPARE PARTS:

The manufacturer shall supply to the Owner the following spare parts:

- a) One impeller.
- b) Forty feet of lifting chain.
- c) One stator.
- d) One rotor.
- e) Upper and lower bearings for one pump.

14.0 MEASUREMENT AND PAYMENT:

Measurement and payment for work included in this Section of the Specifications shall be by lump sum in accordance with Section 01150, Measurement and Payment.

--- END OF SECTION ---

SECTION 223400 - FUEL-FIRED, DOMESTIC-WATER HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Gas-fired, tankless, domestic-water heaters.

1.3 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Commercial domestic-water heaters shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event]."

1.4 ACTION SUBMITTALS

- A. Product Data: For each type and size of domestic-water heater indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings:
 - 1. Wiring Diagrams: For power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Certificates: For fuel-fired, domestic-water heaters, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

- B. Product Certificates: For each type of gas-fired, tankless, domestic-water heater, from manufacturer.
- C. Domestic-Water Heater Labeling: Certified and labeled by testing agency acceptable to authorities having jurisdiction.
- D. Source quality-control reports.
- E. Field quality-control reports.
- F. Warranty: Sample of special warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fuel-fired, domestic-water heaters to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASHRAE/IESNA Compliance: Fabricate and label fuel-fired, domestic-water heaters to comply with ASHRAE/IESNA 90.1.
- C. ASME Compliance:
 - 1. Where ASME-code construction is indicated, fabricate and label commercial, domestic-water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
 - 2. Where ASME-code construction is indicated, fabricate and label commercial, finned-tube, domestic-water heaters to comply with ASME Boiler and Pressure Vessel Code: Section IV.
- D. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61 Annex G, "Drinking Water System Components - Health Effects."

1.8 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.9 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of fuel-fired, domestic-water heaters that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
 - a. Structural failures including storage tank and supports.
 - b. Faulty operation of controls.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal use.
2. Warranty Periods: From date of Substantial Completion.
 - a. Gas-Fired, Tankless, Domestic-Water Heaters:
 - 1) Heat Exchanger: Five years.
 - 2) Controls and Other Components: Three years.
 - b. Compression Tanks: Five years.

PART 2 - PRODUCTS

2.1 GAS-FIRED, TANKLESS, domestic-WATER HEATERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Intellhot I-Series
 2. Bosch Water Heating.
 3. Bradford White Corporation.
 4. Rheem Manufacturing Company; Rheem Water Heating.
 5. Rinnai Corporation.
- B. Standard: ANSI Z21.10.3/CSA 4.3 for gas-fired, instantaneous, domestic-water heaters for indoor application.
- C. Construction: Copper piping or tubing complying with NSF 61 barrier materials for potable water, without storage capacity.
 1. Tappings: ASME B1.20.1 pipe thread.
 2. Pressure Rating: 150 psig.
 3. Heat Exchanger: 316L .
 4. Insulation: Comply with ASHRAE/IESNA 90.1.
 5. Jacket: Metal, with enameled finish.
 6. Burner: For use with tankless, domestic-water heaters and natural-gas] or LP-gas fuel.
 7. Automatic Ignition: Manufacturer's proprietary system for automatic, gas ignition.
 8. Temperature Control: Adjustable thermostat.
- D. Support: Bracket for wall mounting.

2.2 DOMESTIC-WATER HEATER ACCESSORIES

- A. Comply with ANSI/CSA LC 3. Include dimensions not less than base of domestic-water heater, and include drain outlet not less than NPS 3/4 with ASME B1.20.1 pipe threads or with ASME B1.20.7 garden-hose threads.
- B. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1.
- C. Heat-Trap Fittings: ASHRAE 90.2.
- D. Manifold Kits: Domestic-water heater manufacturer's factory-fabricated inlet and outlet piping for field installation, for multiple domestic-water heater installation. Include ball-, butterfly-, or gate-type shutoff valves to isolate each domestic-water heater and calibrated balancing valves to provide balanced flow through each domestic-water heater.
- E. Comply with requirements for ball-, butterfly-, or gate-type shutoff valves specified in Section "Ball Valves for Plumbing Piping," Section "Butterfly Valves for Plumbing Piping," and Section "Gate Valves for Plumbing Piping."
 - 1. Comply with requirements for balancing valves specified in Section "Domestic Water Piping Specialties."
- F. Gas Shutoff Valves: ANSI Z21.15/CSA 9.1-M, manually operated. Furnish for installation in piping.
- G. Gas Pressure Regulators: ANSI Z21.18/CSA 6.3, appliance type. Include 1/2-psig] 2-psig 5-psig pressure rating as required to match gas supply.
- H. Automatic Gas Valves: ANSI Z21.21/CSA 6.5, appliance, electrically operated, on-off automatic valve.
- I. Combination Temperature-and-Pressure Relief Valves: Include relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select relief valves with sensing element that extends into storage tank.
 - 1. Gas-Fired, Domestic-Water Heaters: ANSI Z21.22/CSA 4.4-M.
- J. Pressure Relief Valves: Include pressure setting less than domestic-water heater working-pressure rating.
 - 1. Gas-Fired, Domestic-Water Heaters: ANSI Z21.22/CSA 4.4-M.
- K. Vacuum Relief Valves: ANSI Z21.22/CSA 4.4-M.
- L. Domestic-Water Heater Stands: Manufacturer's factory-fabricated steel stand for floor mounting, capable of supporting domestic-water heater and water. Provide dimension that will support bottom of domestic-water heater a minimum of 18 inches above the floor.

- M. Domestic-Water Heater Mounting Brackets: Manufacturer's factory-fabricated steel bracket for wall mounting, capable of supporting domestic-water heater and water.

2.3 SOURCE QUALITY CONTROL

- A. Factory Tests: Test and inspect assembled domestic-water heaters specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.
- B. Domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Section "Quality Requirements" for retesting and reinspecting requirements and Section "Execution" for requirements for correcting the Work.
- C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 DOMESTIC-WATER HEATER INSTALLATION

- A. Tankless, Domestic-Water Heater Mounting: Install tankless, domestic-water heaters at least 18 inches above floor on wall bracket.
 - 1. Maintain manufacturer's recommended clearances.
 - 2. Arrange units so controls and devices that require servicing are accessible.
 - 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 4. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 5. Anchor domestic-water heaters to substrate.
 - 6. Install shutoff valves on domestic-water-supply piping to domestic-water heaters and on domestic-hot-water outlet piping. Comply with requirements for shutoff valves specified in Section "Ball Valves for Plumbing Piping," Section "Butterfly Valves for Plumbing Piping," and Section "Gate Valves for Plumbing Piping."
- B. Install gas-fired, domestic-water heaters according to NFPA 54.
 - 1. Install gas shutoff valves on gas supply piping to gas-fired, domestic-water heaters without shutoff valves.
 - 2. Install gas pressure regulators on gas supplies to gas-fired, domestic-water heaters without gas pressure regulators if gas pressure regulators are required to reduce gas pressure at burner.
 - 3. Install automatic gas valves on gas supplies to gas-fired, domestic-water heaters if required for operation of safety control.
 - 4. Comply with requirements for gas shutoff valves, gas pressure regulators, and automatic gas valves specified in Section "Facility Liquefied-Petroleum Gas Piping."
- C. Install commercial domestic-water heaters with seismic-restraint devices. Comply with requirements for seismic-restraint devices specified in Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

- D. Install combination temperature-and-pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
- E. Install combination temperature-and-pressure relief valves in water piping for domestic-water heaters without storage. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
- F. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for domestic-water heaters that do not have tank drains. Comply with requirements for hose-end drain valves specified in Section "Domestic Water Piping Specialties."
- G. Assemble and install inlet and outlet piping manifold kits for multiple domestic-water heaters. Fabricate, modify, or arrange manifolds for balanced water flow through each domestic-water heater. Include shutoff valve and thermometer in each domestic-water heater inlet and outlet, and throttling valve in each domestic-water heater outlet. Comply with requirements for valves specified in Section "Ball Valves for Plumbing Piping," Section "Butterfly Valves for Plumbing Piping," and Section "Gate Valves for Plumbing Piping," and comply with requirements for thermometers specified in Section "Meters and Gages for Plumbing Piping."
- H. Install piping-type heat traps on inlet and outlet piping of domestic-water heater storage tanks without integral or fitting-type heat traps.
- I. Fill domestic-water heaters with water.
- J. Charge domestic-water compression tanks with air.

3.2 CONNECTIONS

- A. Comply with requirements for domestic-water piping specified in Section "Domestic Water Piping."
- B. Comply with requirements for fuel-oil piping specified in Section "Facility Fuel-Oil Piping."
- C. Comply with requirements for gas piping specified in [Section "Facility Liquefied-Petroleum Gas Piping."
- D. Drawings indicate general arrangement of piping, fittings, and specialties. Intall per manufacturers installation instructions for service and vent piping.
- E. Where installing piping adjacent to fuel-fired, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.

3.3 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification specified in Section "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
 - 2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Section "Quality Requirements" for retesting and reinspecting requirements and Section "Execution" for requirements for correcting the Work.
- C. Prepare test and inspection reports.

END OF SECTION 223400

SECTION 224213.13 - COMMERCIAL WATER CLOSETS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

1. Water closets.
2. Flushometer valves.
3. Toilet seats.
4. Supports.

1.3 DEFINITIONS

- A. Effective Flush Volume: Average of two reduced flushes and one full flush per fixture.
- B. Remote Water Closet: Located more than 30 feet from other drain line connections or fixture and where less than 1.5 drainage fixture units are upstream of the drain line connection.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for water closets.
 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For flushometer valves to include in operation and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that are packaged with protective covering for storage and identified with labels describing contents.

1. Flushometer-Valve Repair Kits: Equal to [5]percent of amount of each type installed, but no fewer than one [six] of each type.

PART 2 - PRODUCTS

2.1 FLOOR-MOUNTED, BOTTOM-OUTLET WATER CLOSETS

A. Water Closets Floor mounted, bottom outlet, top spud.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Standard America.
 - b. Crane Plumbing, L.L.C.
 - c. Kohler Co.
 - d. Sloan Valve Company.
 - e. TOTO USA, INC.
 - f. Zurn Industries, LLC.
2. Bowl:
 - a. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
 - b. Material: Vitreous china.
 - c. Type: Siphon jet.
 - d. Style: Flushometer valve.
 - e. Height: Standard and Handicapped/elderly, complying with ICC/ANSI A117.1].
 - f. Rim Contour: Elongated.
 - g. Water Consumption: 1.28 gal. per flush.
 - h. Spud Size and Location: NPS 1-1/2; top.
 - i. Color: White.
3. Bowl-to-Drain Connecting Fitting: ASTM A 1045 or ASME A112.4.3.
4. Flushometer Valve: Piston type
5. Toilet Seat: White, open front elongated, self sustaining check hinge

2.2 FLUSHOMETER VALVES

A. Lever-Handle, Diaphragm Flushometer Valves

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Delany Products.
 - b. Sloan Valve Company.
 - c. Zurn Industries, LLC.
 - d. American Standard
2. Standard: ASSE 1037.
3. Minimum Pressure Rating: 125 psig.

4. Features: Include integral check stop and backflow-prevention device.
5. Material: Brass body with corrosion-resistant components.
6. Exposed Flushometer-Valve Finish: Chrome plated.
7. Panel Finish: Chrome plated or stainless steel.
8. Style: Exposed].
9. Consumption: 1.28 gal. per flush.
10. Minimum Inlet: NPS 1.
11. Minimum Outlet: NPS 1-1/4.
12. .

B. Lever-Handle, Piston Flushometer Valves

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Kohler Co.
 - b. Sloan Valve Company.
 - c. TOTO USA, INC.
 - d. Zurn Industries, LLC.
 - e. American Standard
2. Standard: ASSE 1037.
3. Minimum Pressure Rating: 125 psig.
4. Features: Include integral check stop and backflow-prevention device.
5. Material: Brass body with corrosion-resistant components.
6. Exposed Flushometer-Valve Finish: Chrome plated.
7. Panel Finish: Chrome plated or stainless steel.
8. Style: Exposed].
9. Consumption: 1.28 gal. per flush.
10. Minimum Inlet: NPS 1.
11. Minimum Outlet: NPS 1-1/4.

2.3 TOILET SEATS

A. Toilet Seats

1. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
 - a. American Standard America.
 - b. Bemis Manufacturing Company.
 - c. Church Seats; Bemis Manufacturing Company.
 - d. Kohler Co.
 - e. TOTO USA, INC.
 - f. Zurn Industries, LLC.
 - g. Benekee
2. Standard: IAPMO/ANSI Z124.5.

3. Material: Plastic.
4. Type: Commercial (Standard)].
5. Shape: Elongated rim, open front.
6. Hinge: Self-sustaining.
7. Hinge Material: Noncorroding metal.
8. Color: White.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before water-closet installation.
- B. Examine walls and floors for suitable conditions where water closets will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Water-Closet Installation:

1. Install level and plumb according to roughing-in drawings.
2. Install floor-mounted water closets on bowl-to-drain connecting fitting attachments to piping or building substrate.

B. Support Installation:

1. Install supports, affixed to building substrate, for floor-mounted, back-outlet water closets.
2. Use carrier supports with waste-fitting assembly and seal.
3. Install floor-mounted, back-outlet water closets attached to building floor substrate, onto waste-fitting seals; and attach to support.
4. Install wall-mounted, back-outlet water-closet supports with waste-fitting assembly and waste-fitting seals; and affix to building substrate.

C. Flushometer-Valve Installation:

1. Install flushometer-valve, water-supply fitting on each supply to each water closet.
2. Attach supply piping to supports or substrate within pipe spaces behind fixtures.
3. Install lever-handle flushometer valves for accessible water closets with handle mounted on open side of water closet.
4. Install actuators in locations that are easy for people with disabilities to reach.
5. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

D. Install toilet seats on water closets.

E. Wall Flange and Escutcheon Installation:

1. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations and within cabinets and millwork.
2. Install deep-pattern escutcheons if required to conceal protruding fittings.
3. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."

F. Joint Sealing:

1. Seal joints between water closets and walls and floors using sanitary-type, one-part, mildew-resistant silicone sealant.
2. Match sealant color to water-closet color.
3. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

3.3 CONNECTIONS

- A. Connect water closets with water supplies and soil, waste, and vent piping. Use size fittings required to match water closets.
- B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."
- C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."
- D. Where installing piping adjacent to water closets, allow space for service and maintenance.

3.4 ADJUSTING

- A. Operate and adjust water closets and controls. Replace damaged and malfunctioning water closets, fittings, and controls.
- B. Adjust water pressure at flushometer valves to produce proper flow.
- C. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

3.5 CLEANING AND PROTECTION

- A. Clean water closets and fittings with manufacturers' recommended cleaning methods and materials.
- B. Install protective covering for installed water closets and fittings.
- C. Do not allow use of water closets for temporary facilities unless approved in writing by Owner.

END OF SECTION 224213.13

SECTION 224216.13 - COMMERCIAL LAVATORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

1. Lavatories.
2. Faucets.
3. Supports.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for lavatories.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Counter cutout templates for mounting of counter-mounted lavatories.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For lavatories and faucets to include in operation and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - a. Servicing and adjustments of automatic faucets.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Faucet Washers and O-Rings: Equal to 10] percent of amount of each type and size installed.
2. Faucet Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed.

PART 2 - PRODUCTS

2.1 VITREOUS-CHINA, WALL-MOUNTED LAVATORIES

A. Lavatory>: Vitreous china, wall mounted, with back.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Standard America.
 - b. Briggs Plumbing Products, Inc.
 - c. Crane Plumbing, L.L.C.
 - d. Sloan Valve Company.
 - e. Zurn Industries, LLC.
2. Fixture:
 - a. Standard: ASME A112.19.2/CSA B45.1.
 - b. Type: For wall hanging.
 - c. Nominal Size: Oval, 19 by 16 inches].
 - d. Faucet-Hole Punching Three holes, 4-inch centers.
 - e. Faucet-Hole Location: Top.
 - f. Color: [White]
 - g. Mounting Material: Chair carrier.
3. Faucet: Insert lavatory faucet designation from "Solid-Brass, Manually Operated Faucets"
4. Lavatory Mounting Height: Standard and Handicapped/elderly according to ICC A117.1.

2.2 SOLID-BRASS, MANUALLY OPERATED FAUCETS

- A. NSF Standard: Comply with NSF/ANSI 61 Annex G, "Drinking Water System Components - Health Effects," for faucet materials that will be in contact with potable water.
- B. Lavatory Faucets>: Manual-type,two-handle mixing, commercial, solid-brass valve.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Standard America.
 - b. Chicago Faucets; Geberit Company.
 - c. Delta Faucet Company.
 - d. Elkay Manufacturing Co.

- e. Gerber Plumbing Fixtures LLC.
- f. Just Manufacturing.
- g. Kohler Co.
- h. T&S Brass and Bronze Works, Inc.
- i. Zurn Industries, LLC.

- 2. Standard: ASME A112.18.1/CSA B125.1.
- 3. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and fixture receptor.
- 4. Body Type: Centerset.
- 5. Body Material: Commercial, solid brass.
- 6. Finish: Polished chrome plate.
- 7. Maximum Flow Rate: 0.5 gpm].
- 8. Mounting Type: Deck, exposed.
- 9. Valve Handle(s): Wrist blade, 4 inches.
- 10. Spout: Rigid type.
- 11. Spout Outlet: Aerator.
- 12. Operation: Compression, manual.

2.3 SUPPLY FITTINGS

- A. NSF Standard: Comply with NSF/ANSI 61 Annex G, "Drinking Water System Components - Health Effects," for supply-fitting materials that will be in contact with potable water.
- B. Standard: ASME A112.18.1/CSA B125.1.
- C. Supply Piping: Chrome-plated-brass pipe or chrome-plated copper tube matching water-supply piping size. Include chrome-plated-brass or stainless-steel wall flange.
- D. Supply Stops: Chrome-plated-brass, one-quarter-turn, ball-type or compression valve with inlet connection matching supply piping.
- E. Operation: Wheel handle.
- F. Risers:
 - 1. NPS 1/2.
 - 2. Chrome-plated, rigid-copper-pipe and brass straight or offset tailpieces riser.

2.4 WASTE FITTINGS

- A. Standard: ASME A112.18.2/CSA B125.2.
- B. Drain: Grid type with NPS 1-1/4 offset and straight tailpiece.
- C. Trap:
 - 1. Size: NPS 1-1/2 by NPS 1-1/4.
 - 2. Material: Chrome-plated, two-piece, cast-brass trap and swivel elbow with 0.032-inch-thick brass tube to wall]; and chrome-plated, brass or steel wall flange.

3. Material: Stainless-steel, two-piece trap and swivel elbow with 0.012-inch-thick stainless-steel tube to wall; and stainless-steel wall flange.

2.5 SUPPORTS

- A. Type II Lavatory Carrier:
 1. Standard: ASME A112.6.1M.
- B. Type III Lavatory Carrier:
 1. Standard: ASME A112.6.1M.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before lavatory installation.
- B. Examine counters and walls for suitable conditions where lavatories will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install lavatories level and plumb according to roughing-in drawings.
- B. Install supports, affixed to building substrate, for wall-mounted lavatories.
- C. Install accessible wall-mounted lavatories at handicapped/elderly mounting height for people with disabilities or the elderly, according to ICC/ANSI A117.1.
- D. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."
- E. Seal joints between lavatories, counters, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."
- F. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible lavatories. Comply with requirements in Section 220719 "Plumbing Piping Insulation."

3.3 CONNECTIONS

- A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."
- C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

3.4 ADJUSTING

- A. Operate and adjust lavatories and controls. Replace damaged and malfunctioning lavatories, fittings, and controls.
- B. Adjust water pressure at faucets to produce proper flow.
- C. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

3.5 CLEANING AND PROTECTION

- A. After completing installation of lavatories, inspect and repair damaged finishes.
- B. Clean lavatories, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.
- C. Provide protective covering for installed lavatories and fittings.
- D. Do not allow use of lavatories for temporary z
- E. efacilities unless approved in writing by Owner.

END OF SECTION 224216.13

SECTION 224216.16 - COMMERCIAL SINKS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 1. Service sinks.
 2. Utility sinks.
 3. Sink faucets.
 4. Laminar-flow, faucet-spout outlets.
 5. Supply fittings.
 6. Waste fittings.
 7. Supports.

1.3 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Counter cutout templates for mounting of counter-mounted lavatories. Where conflicts arise between mechanical drawings and architectural drawings, architectural drawings shall govern.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For sinks to include in maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Faucet Washers and O-Rings: Equal to 10 percent of amount of each type and size installed.
 2. Faucet Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed.

PART 2 - PRODUCTS

2.1 SERVICE BASINS

A. Service Basins Plastic, floor mounted.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

- a. Acorn.
- b. fiat.
- c. Zurn Industries, LLC.
- d.

2. Fixture:

- a. Standard: IAPMO/ANSI Z124.6.
- b. Material: Cast polymer.
- c. Nominal Size: 24 by 24 by 10 inches.
- d. Tiling Flange: Not required.
- e. Rim Guard: On all top surfaces.
- f. Color: white.
- g. Drain: Grid with NPS 2 outlet.

3. Mounting: On floor and flush to wall.

4. Faucet: Wall mounted with integral vacuum breaker and stops. Faucets shall be same manufacturer of service sink..

2.2 UTILITY SINKS

A. Utility Sinks Stainless steel, counter mounted.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Elkay Manufacturing Co.
- b. Just Manufacturing.
- c. American Standard

2. Fixture:

- a. Standard: ASME A112.19.3/CSA B45.4.
- b. Type: Ledge back.
- c. Number of Compartments: As shown on contract documents
- d. Overall Dimensions: as noted on contract documents.
- e. Metal Thickness: [0.050 inch]
- f. Compartment:
 - 1) Drain: Grid with NPS 1-1/2 tailpiece and twist drain Grid with NPS 2 tailpiece and twist drain NPS 1-1/2 tailpiece with stopper.

- 2) Drain Location: Centered in compartment.
3. Faucet(s): .
 - a. Number Required: One.
 - b. Mounting: On ledge.
4. Supply Fittings:
 - a. Standard: ASME A112.18.1/CSA B125.1.
 - b. Supplies: Chrome-plated brass compression stop with inlet connection matching water-supply piping type and size.
 - 1) Operation: Wheel handle.
 - 2) Risers: NPS 1/2, chrome-plated, rigid-copper pipe].
5. Waste Fittings:
 - a. Standard: ASME A112.18.2/CSA B125.2.
 - b. Trap(s):
 - 1) Size: NPS 1-1/2 NPS 2.
 - 2) Material: Chrome-plated, two-piece, cast-brass trap and swivel elbow with 0.032-inch- thick brass tube to wall] two-piece, cast-brass trap and ground-joint swivel elbow with 0.032-inch- thick brass tube to wall; and chrome-plated brass or steel wall flange.
 - 3) Material: Stainless-steel, two-piece trap and swivel elbow with 0.012-inch- thick stainless-steel tube to wall; and stainless-steel wall flange.
 - c. Continuous Waste:
 - 1) Size: NPS 1-1/2.
 - 2) Material: Chrome-plated, 0.032-inch- thick brass tube.
6. Mounting: On counter with sealant.

2.3 SINK FAUCETS

- A. NSF Standard: Comply with NSF/ANSI 61 Annex G, "Drinking Water System Components - Health Effects," for faucet-spout materials that will be in contact with potable water.
- B. Sink Faucets Manual type, two-lever-handle mixing valve.
 1. Commercial, Solid-Brass Faucets.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) American Standard America.
 - 2) Chicago Faucets; Geberit Company.
 - 3) Delta Faucet Company.

- 4) Elkay Manufacturing Co.
- 5) Just Manufacturing.
- 6) Kohler Co.
- 7) Moen Incorporated.
- 8) Sloan Valve Company.
- 9) Speakman Company.
- 10) T&S Brass and Bronze Works, Inc.
- 11) Zurn Industries, LLC.

2. Standard: ASME A112.18.1/CSA B125.1.
3. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and sink receptor.
4. Body Type: Centerset.
5. Body Material: Commercial, solid brass.
6. Finish: Chrome plated.
7. Maximum Flow Rate: 2.2 gpm.
8. Handle(s): Wrist blade, 4 inches Not applicable.
9. Mounting Type: Deck, exposed.
10. Spout Type: Swing, round tubular Swing, solid brass.
11. Vacuum Breaker: Not required for hose outlet.
12. Spout Outlet: Aerato.

2.4 WASTE FITTINGS

- A. Standard: ASME A112.18.2/CSA B125.2.
- B. Drain: Grid type with NPS 1-1/2 offset and straight tailpiece.
- C. Trap:
 1. Size: NPS 1-1/2.
 2. Material: Chrome-plated, two-piece, cast-brass trap and swivel elbow with 0.032-inch- thick brass tube to wall; and chrome-plated brass or steel wall flange.
 3. Material: Stainless-steel, two-piece trap and swivel elbow with 0.012-inch- thick stainless-steel tube to wall; and stainless-steel wall flange.

2.5 GROUT

- A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Nonshrink; recommended for interior and exterior applications.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

2.6 SUPPORTS

A. Water Closet Carrier:

1. Standard: ASME A112.6.1M.
2. Description: Waste-fitting assembly, as required to match drainage piping material and arrangement with faceplates, couplings gaskets, and feet; bolts and hardware matching fixture.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before sink installation.
- B. Examine walls, floors, and counters for suitable conditions where sinks will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install sinks level and plumb according to roughing-in drawings.
- B. Install supports, affixed to building substrate, for wall-hung sinks.
- C. Install accessible wall-mounted sinks at handicapped/elderly mounting height according to ICC/ANSI A117.1.
- D. Set floor-mounted sinks in leveling bed of cement grout.
- E. Install water-supply piping with stop on each supply to each sink faucet.
 1. Exception: Use ball or gate valves if supply stops are not specified with sink. Comply with valve requirements specified in Section 220523.12 "Ball Valves for Plumbing Piping" and Section 220523.15 "Gate Valves for Plumbing Piping."
 2. Install stops in locations where they can be easily reached for operation.
- F. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."
- G. Seal joints between sinks and counters, floors, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."
- H. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible sinks. Comply with requirements in Section 220719 "Plumbing Piping Insulation."

3.3 CONNECTIONS

- A. Connect sinks with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."
- C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

3.4 ADJUSTING

- A. Operate and adjust sinks and controls. Replace damaged and malfunctioning sinks, fittings, and controls.
- B. Adjust water pressure at faucets to produce proper flow.

3.5 CLEANING AND PROTECTION

- A. After completing installation of sinks, inspect and repair damaged finishes.
- B. Clean sinks, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.
- C. Provide protective covering for installed sinks and fittings.
- D. Do not allow use of sinks for temporary facilities unless approved in writing by Owner.

END OF SECTION 224216.16

SECTION 224223 - COMMERCIAL SHOWERS

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Individual shower receptors.
2. Shower faucets.
3. Shower basins.
4. Group showers.
5. Outdoor showers.
6. Grout.

B. Related Requirements:

1. Section 224100 "Residential Plumbing Fixtures" for residential showers.
2. Section 224300 "Medical Plumbing Fixtures" for healthcare showers.
3. Section 224500 "Emergency Plumbing Fixtures" for emergency showers.
4. Section 224600 "Security Plumbing Fixtures" for security showers.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for showers and basins.
2. Include rated capacities, operating characteristics, and furnished specialties and accessories.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For shower faucets to include in maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Faucet Washers and O-Rings: Equal to 10 percent of amount of each type and size installed.

2. Faucet Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed.

PART 2 - PRODUCTS

2.1 INDIVIDUAL SHOWERS

A. Individual FRP Showers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Aqua Glass Corporation.
 - b. Clarion Bathware.
 - c. LASCO Bathware.
 - d. Sterling.
2. General: FRP, accessible, shower enclosure with faucet and receptor and appurtenances.
3. Standard: ANSI Z124.1.2.
4. Type: One-piece unit without top Sectional unit without top.
5. Style: Handicapped/wheelchair.Coordinate "Faucet" Subparagraph below with "Shower Faucets" Article.
6. Nominal Size and Shape: 36 by 36 inches square.
7. Color: White.
8. Bathing Surface: Slip resistant according to ASTM F 462.
9. Outlet: Drain with NPS 2 outlet.
10. Shower Rod and CurtainRequired.
11. Grab Bar: [ASTM F 446, mounted on support area back wall].

2.2 SHOWER FAUCETS

- A. NSF Standard: Comply with NSF 61 Annex G, "Drinking Water System Components - Health Effects," for shower materials that will be in contact with potable water.
- B. Shower Faucets Insert drawing designation>:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Chicago Faucets; Geberit Company.
 - b. Kohler Co.
 - c. Leonard Valve Company.
 - d. Moen Incorporated.
 - e. Powers.
 - f. Speakman Company.
 - g. Zurn Industries, LLC.

- h. American Standard
- 2. Description: Single-handle, pressure-balance mixing valve with hot- and cold-water indicators; check stops; and shower head.
- 3. Faucet:
 - a. Standards: ASME A112.18.1/CSA B125.1 and ASSE 1016.
 - b. Body Material: Solid brass.
 - c. Finish: Polished chrome plate.
 - d. Shower-Arm, Flow-Control Fitting: 1.5 gpm.
 - e. EPA WaterSense: Required.
 - f. Mounting: Concealed].
 - g. Operation: Single-handle, twist or rotate control.
 - h. Antiscald Device: Integral with mixing valve.
 - i. Check Stops: Check-valve type, integral with or attached to body; on hot- and cold-water supply connections.
- 4. Supply Connections: NPS 1/2.
- 5. Shower Head:
 - a. Standard: ASME A112.18.1/CSA B125.1.
 - b. Type: [Ball joint with arm and flange].
 - c. Shower Head Material: Metallic with chrome-plated finish.
 - d. Spray Pattern: [Adjustable].
 - e. Integral Volume Control: Not required].
 - f. Shower-Arm, Flow-Control Fitting: [Not required].
 - g. Temperature Indicator: Not required.
- C. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- D. Characteristics: Nonshrink; recommended for interior and exterior applications.
- E. Design Mix: 5000-psi, 28-day compressive strength.
- F. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in of water-supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before shower installation.
- B. Examine walls and floors for suitable conditions where showers will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Assemble shower components according to manufacturers' written instructions.
- B. Install showers level and plumb according to roughing-in drawings.
- C. Install water-supply piping with stop on each supply to each shower faucet.
 - 1. Exception: Use ball or gate valves if supply stops are not specified with shower. Comply with valve requirements specified in Section 220523.12 "Ball Valves for Plumbing Piping" and Section 220523.15 "Gate Valves for Plumbing Piping."
 - 2. Install stops in locations where they can be easily reached for operation.
- D. Install shower flow-control fittings with specified maximum flow rates in shower arms.
- E. Set shower receptors] in leveling bed of cement grout.
- F. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheons requirements specified in Section 220518 "Escutcheons for Plumbing Piping."
- G. Seal joints between showers and floors and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

3.3 CONNECTIONS

- A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."
- C. Comply with traps and soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

3.4 ADJUSTING

- A. Operate and adjust showers and controls. Replace damaged and malfunctioning showers, fittings, and controls.
- B. Adjust water pressure at faucets to produce proper flow.

3.5 CLEANING AND PROTECTION

- A. After completing installation of showers and basins], inspect and repair damaged finishes.
- B. Clean showers faucets, and other fittings with manufacturers' recommended cleaning methods and materials.

- C. Provide protective covering for installed fixtures and fittings.
- D. Do not allow use of showers and basins] for temporary facilities unless approved in writing by Owner.

END OF SECTION 224223

SECTION 224500 - EMERGENCY PLUMBING FIXTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Combination units.

1.3 DEFINITIONS

- A. Accessible Fixture: Emergency plumbing fixture that can be approached, entered, and used by people with disabilities.
- B. Plumbed Emergency Plumbing Fixture: Fixture with fixed, potable-water supply.
- C. Self-Contained Emergency Plumbing Fixture: Fixture with flushing-fluid-solution supply.
- D. Tepid: Moderately warm.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include flow rates and capacities, furnished specialties, and accessories.
- B. Shop Drawings: Diagram power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

- A. Product Certificates: Submit certificates of performance testing specified in "Source Quality Control" Article.
- B. Field quality-control test reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For emergency plumbing fixtures to include in operation and maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Flushing-Fluid Solution: Separate lot and equal to at least [200] percent of amount of solution installed for each self-contained unit.

1.8 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ANSI Standard: Comply with ANSI Z358.1, "Emergency Eyewash and Shower Equipment."
- C. NSF Standard: Comply with NSF 61 Annex G, "Drinking Water System Components - Health Effects," for fixture materials that will be in contact with potable water.
- D. Regulatory Requirements: Comply with requirements in ICC/ANSI A117.1, "Accessible and Usable Buildings and Facilities Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act for plumbing fixtures for people with disabilities.

PART 2 - PRODUCTS

2.1 COMBINATION UNITS

- A. Standard, Plumbed Emergency Shower with Eyewash Combination Units.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Acorn Safety
 - b. Bradley Corporation
 - c. Encon Safety Products
 - d. Guardian Equipment Co.
 - e. Haws Corporation
 - f. Sellstrom Manufacturing Company
 - g. Speakman Company
 - h. WaterSaver Faucet Co.
 - 2. Piping:
 - a. Material: Galvanized steel
 - b. Unit Supply: NPS 1-1/4 minimum
 - c. Unit Drain: Outlet at back or side near bottom.
 - 3. Shower:

- a. Capacity: Not less than 20 gpm for at least 15 minutes.
 - b. Supply Piping: NPS 1 with flow regulator and stay-open control ball valve.
 - c. Control-Valve Actuator: Pull rod
 - d. Shower Head: 8-inch minimum diameter, powder-Coated Galvanized steel.
 - e. Mounting: Pedestal.
4. Eyewash Unit:
- a. Capacity: Not less than 4.5 gpm for at least 15 minutes.
 - b. Supply Piping: NPS 1/2 with flow regulator and stay-open control valve.
 - c. Control-Valve Actuator: Paddle.
 - d. Spray-Head Assembly: Two receptor-mounted spray heads.
 - e. Receptor: Powder-coated galvanized steel bowl.
 - f. Mounting: Attached shower pedestal.
- B. Accessible, Plumbed Emergency Shower with Eyewash Combination Units:
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
- a. Acorn Safety
 - b. Bradley Corporation
 - c. Encon Safety Products
 - d. Guardian Equipment Co.
 - e. Haws Corporation
 - f. Sellstrom Manufacturing Company
 - g. Speakman Company
 - h. WaterSaver Faucet Co.
2. Piping:
- a. Material: Galvanized steel
 - b. Unit Supply: NPS 1-1/4 minimum
 - c. Unit Drain: Outlet at back or side near bottom.
3. Shower:
- a. Capacity: Not less than 20 gpm for at least 15 minutes.
 - b. Supply Piping: NPS 1 with flow regulator and stay-open control valve.
 - c. Control-Valve Actuator: Pull rod Shower Head: 8-inch- minimum diameter, chrome-plated brass or stainless steel or plastic.
 - d. Mounting: Pedestal.
4. Eyewash Unit:
- a. Capacity: Not less than 0.4 gpm for at least 15 minutes.
 - b. Supply Piping: NPS 1/2 with flow regulator and stay-open control valve.
 - c. Control-Valve Actuator: Paddle.
 - d. Spray-Head Assembly: Two receptor-mounted spray heads.
 - e. Receptor: Chrome-plated brass or stainless-steel or Plastic bowl.
 - f. Mounting: Attached shower pedestal.

- g. Drench-Hose Option: May be provided instead of eyewash unit.
 - 1) Capacity: Not less than 0.4 gpm for at least 15 minutes.
 - 2) Drench Hose: Hand-held spray head with squeeze-handle actuator and hose.
 - 3) Mounting: Bracket on shower pedestal.
- h.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for water and waste piping systems to verify actual locations of piping connections before plumbed emergency plumbing fixture installation.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EMERGENCY PLUMBING FIXTURE INSTALLATION

- A. Assemble emergency plumbing fixture piping, fittings, control valves, and other components.
- B. Install fixtures level and plumb.
- C. Fasten fixtures to substrate.
- D. Install shutoff valves in water-supply piping to fixtures. Use ball or gate valve if specific type valve is not indicated. Install valves chained or locked in open position if permitted. Install valves in locations where they can easily be reached for operation. Comply with requirements for valves specified in Section "Ball Valves for Plumbing Piping" and Section "Gate Valves for Plumbing Piping."
 - 1. Exception: Omit shutoff valve on supply to group of plumbing fixtures that includes emergency equipment.
 - 2. Exception: Omit shutoff valve on supply to emergency equipment if prohibited by authorities having jurisdiction.
- E. Install dielectric fitting in supply piping to emergency equipment if piping and equipment connections are made of different metals. Comply with requirements for dielectric fittings specified in Section "Domestic Water Piping."
- F. Install trap and waste piping on drain outlet of emergency equipment receptors that are indicated to be directly connected to drainage system. Comply with requirements for waste piping specified in Section "Sanitary Waste and Vent Piping."
- G. Install indirect waste piping on drain outlet of emergency equipment receptors that are indicated to be indirectly connected to drainage system. Comply with requirements for waste piping specified in Section "Sanitary Waste and Vent Piping."

- H. Install escutcheons on piping wall and ceiling penetrations in exposed, finished locations. Comply with requirements for escutcheons specified in Section "Escutcheons for Plumbing Piping."
- I. Fill self-contained fixtures with flushing fluid.

3.3 CONNECTIONS

- A. Connect cold-water-supply piping to plumbed emergency plumbing fixtures not having water-tempering equipment. Comply with requirements for cold-water piping specified in Section "Domestic Water Piping."
- B. Connect hot- and cold-water-supply piping to hot- and cold-water, water-tempering equipment. Connect output from water-tempering equipment to emergency plumbing fixtures. Comply with requirements for hot- and cold-water piping specified in Section "Domestic Water Piping."
- C. Connect cold water and electrical power to electric heating water-tempering equipment. Comply with requirements for cold-water piping specified in Section "Domestic Water Piping."
- D. Directly connect emergency plumbing fixture receptors with trapped drain outlet to sanitary waste and vent piping. Comply with requirements for waste piping specified in Section "Sanitary Waste and Vent Piping."
- E. Indirectly connect emergency plumbing fixture receptors without trapped drain outlet to storm drainage piping or trench drain piping from apparatus bay.
- F. Where installing piping adjacent to emergency plumbing fixtures, allow space for service and maintenance of fixtures.

3.4 IDENTIFICATION

- A. Install equipment nameplates or equipment markers on emergency plumbing fixtures and equipment and equipment signs on water-tempering equipment. Comply with requirements for identification materials specified in Section "Identification for Plumbing Piping and Equipment."

3.5 FIELD QUALITY CONTROL

- A. Mechanical-Component Testing: After plumbing connections have been made, test for compliance with requirements. Verify ability to achieve indicated capacities.
- B. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection.
 - 2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation.

4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Emergency plumbing fixtures will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

3.6 ADJUSTING

- A. Adjust or replace fixture flow regulators for proper flow.
- B. Adjust equipment temperature settings.

END OF SECTION 224500

SECTION 224716 - PRESSURE WATER COOLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes pressure water coolers and related components.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of pressure water cooler.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
 - 3.
- B. Shop Drawings: Include diagrams for power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For pressure water coolers to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 PRESSURE WATER COOLERS

- A. Standard and, wheelchair accessible.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. acorn.
 - b. Elkay Manufacturing Co.
 - c. Halsey-Taylor
 - 2. Standards:

- a. Comply with NSF 61 Annex G.
 - b. Comply with ASHRAE 34, "Designation and Safety Classification of Refrigerants," for water coolers. Provide HFC 134a (tetrafluoroethane) refrigerant unless otherwise indicated.
3. Cabinet: Bi-level with two attached cabinets Bi-level with two attached cabinets and with a bi-level skirt kit, all stainless steel.
 4. Bubbler: One, with adjustable stream regulator, located on each cabinet deck.
 5. Control: Push button] or Push bar
 6. Drain: Grid with NPS 1-1/4 tailpiece.
 7. Supply: NPS 3/8 with shutoff valve.
 8. Waste Fitting: ASME A112.18.2/CSA B125.2, NPS 1-1/4 brass P-trap.
 9. Filter: One or more water filters complying with NSF 42 and NSF 53 for cyst and lead reduction to below EPA standards; with capacity sized for unit peak flow rate.
 10. Cooling System: Electric, with hermetically sealed compressor, cooling coil, air-cooled condensing unit, corrosion-resistant tubing, refrigerant, corrosion-resistant-metal storage tank, and adjustable thermostat.
 - a. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 11. Capacities and Characteristics:
 - a. Cooled Water: 8 gph
 - b. Ambient-Air Temperature: 90 deg F.
 - c. Inlet-Water Temperature: 80 deg F.
 - d. Cooled-Water Temperature: 50 deg F.
 - e. Electrical Characteristics:
 - 1) Motor Horsepower: 1/6.
 - 2) Volts: 120-V ac.
 - 3) Phase: Single.
 - 4) Hertz: 60.
 12. Support: Type I Water Cooler Carrier.
 13. Water Cooler Mounting Height: Standard/Handicapped/elderly according to ICC A117.1.
- B. Pressure Water Coolers Semirecessed, wheelchair accessible.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. acorn.
 - b. Elkay Manufacturing Co.
 - c. Halsey Taylor.
 2. Standards:
 - a. Comply with NSF 61 Annex G.

- b. Comply with ASHRAE 34, "Designation and Safety Classification of Refrigerants," for water coolers. Provide HFC 134a (tetrafluoroethane) refrigerant unless otherwise indicated.
 - c. Comply with ICC A117.1.
3. Cabinet: [All stainless steel].
 4. Bubbler: One, with adjustable stream regulator, located on deck.
 5. Control: Push button].
 6. Drain: Grid with NPS 1-1/4 tailpiece.
 7. Supply: NPS 3/8 with shutoff valve.
 8. Waste Fitting: ASME A112.18.2/CSA B125.2, NPS 1-1/4 brass P-trap.
 9. Filter: One or more water filters complying with NSF 42 and NSF 53 for cyst and lead reduction to below EPA standards; with capacity sized for unit peak flow rate.
 10. Cooling System: Electric, with [precooler,]hermetically sealed compressor, cooling coil, air-cooled condensing unit, corrosion-resistant tubing, refrigerant, corrosion-resistant-metal storage tank, and adjustable thermostat.
 - a. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 11. Capacities and Characteristics:
 - a. Cooled Water: 8 gph].
 - b. Ambient-Air Temperature: 90 deg F.
 - c. Inlet-Water Temperature: 80 deg F.
 - d. Cooled-Water Temperature: 50 deg F.
 - e. Electrical Characteristics:
 - 1) Motor Horsepower: 1/6].
 - 2) Volts: 120-V ac.
 - 3) Phase: Single.
 - 4) Hertz: 60.
 12. Support: Mounting frame or brackets for attaching to substrate.

2.2 SUPPORTS

A. Type I Water Cooler Carrier:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Josam Company.
 - b. Wade Drains.
 - c. Watts; a Watts Water Technologies company.
 - d. Zurn Industries, LLC.
2. Standard: ASME A112.6.1M.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for water-supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before fixture installation.
- B. Examine walls and floors for suitable conditions where fixtures will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install fixtures level and plumb according to roughing-in drawings. For fixtures indicated for children, install at height required by authorities having jurisdiction.
- B. Set freestanding pressure water coolers on floor.
- C. Install off-the-floor carrier supports, affixed to building substrate, for wall-mounted fixtures.
- D. Install mounting frames, affixed to building construction, and attach recessed, pressure water coolers to mounting frames.
- E. Install water-supply piping with shutoff valve on supply to each fixture to be connected to domestic-water distribution piping. Use ball or gate valve. Install valves in locations where they can be easily reached for operation. Valves are specified in Section 220523.12 "Ball Valves for Plumbing Piping" and Section 220523.15 "Gate Valves for Plumbing Piping."
- F. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.
- G. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."
- H. Seal joints between fixtures and walls using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

3.3 CONNECTIONS

- A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."
- C. Install ball or gate shutoff valve on water supply to each fixture.[Install valve upstream from filter for water cooler.] Comply with valve requirements specified in Section 220523.12 "Ball Valves for Plumbing Piping" and Section 220523.15 "Gate Valves for Plumbing Piping."

- D. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

3.4 ADJUSTING

- A. Adjust fixture flow regulators for proper flow and stream height.
- B. Adjust pressure water-cooler temperature settings.

3.5 CLEANING

- A. After installing fixture, inspect unit. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.
- B. Clean fixtures, on completion of installation, according to manufacturer's written instructions.
- C. Provide protective covering for installed fixtures.
- D. Do not allow use of fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 224716

SECTION 230000 - GENERAL MECHANICAL PROVISIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.

1.2 SUMMARY

- A. Section includes general provisions covering the contract documents for HVAC Systems.

1.3 DEFINITIONS

- A. Provide shall mean "Furnish, install and connect."
- B. Piping shall mean "pipe installed with all specified fittings, valves and accessories, and forming a complete system."
- C. HVAC shall mean "Heating, Ventilation and Air Conditioning."

1.4 INFORMATIONAL SUBMITTALS

- A. Electrical Coordination Drawings: In addition to submittal requirements of other Division 23 Sections, submit a document approved by the project Electrical Contractor certifying that all mechanical equipment being furnished under Division 23 complies with the electrical characteristics of the source power which will be furnished under Division 26.
- B. Model numbers listed on the Mechanical Contract Documents shall not be construed to indicate electrical characteristics. Electrical characteristics of mechanical equipment shall be as indicated on the Electrical Contract Documents.
- C. Review of Submittals does not relieve the Contractor of any of the requirements of the Contract Documents. Failure by the Engineer to document errors and omissions in the Contractor's submittals during the Engineer's submittal review does not constitute a waiver of any of the requirements of the original Contract Documents.

1.5 CLOSEOUT SUBMITTALS

- A. Installation Instructions: Two binders containing manufacturer's installation instructions for all equipment furnished under Division 23 shall be furnished by the Contractor. One binder shall be kept in the General Contractor's office at the job site. The other binder shall be delivered to the Engineer upon acceptance by the Architect of the Submittals.

- B. Operation and Maintenance Instructions: Three copies of equipment O&M manuals contained in rigid 3-ring binders shall be submitted to the Owner a minimum of 15 days prior to equipment/systems training. Binders shall have permanent labels on the spine and front cover indicating project name, project number, building name and contents. Model and serial numbers of equipment shall be shown on the cover of their respective O&M manual(s).

1.6 QUALITY ASSURANCE

- A. HVAC Installer Qualifications:
 - 1. HVAC Subcontractor shall have a current Class II Conditioned Air Contractors License for the state in which the project is being constructed. The Subcontractor shall have as part of the Firm a Service Department qualified to service all systems installed in the project, or have a written agreement with a Service Agency qualified to provide such service. The Service Department or Agency shall be on call at all hours.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Material storage
 - 1. All materials and equipment stored on the jobsite shall be elevated above the ground and stored under suitable weather cover. Materials and equipment shall not be stored in areas subjected to localized flooding.
 - 2. Manufacturer's original shipping packaging and protective coverings shall be left in place until the equipment is prepared for installation.
- B. Electrical enclosure protection
 - 1. During construction, all protective covers and other devices shall be left in place that protect against inadvertent contact with live electrical circuits.
 - 2. All warning labels related to electrical and rotating equipment hazards shall be in place prior to energizing mechanical equipment circuits.
- C. Protection of ductwork and piping
 - 1. Maintain temporary closures on the ends of all ductwork and piping as the installation work progresses. Temporary closures include plastic sheeting, tape and appropriate caps and covers.
 - 2. Where debris enters piping during installation, steps shall be taken to clean the interior of the pipe prior to placing in service.
 - 3. Where debris enters ductwork during installation the duct interior shall be cleaned prior to placing in service.
 - 4. All lined ductwork shall be kept clean and dry. Any lined duct must be removed from the job site if moisture is discovered in installed or stored ductwork.
- D. Roof protection: All penetrations through roofs, including roof curbs, piping curbs and roof drainage system elements shall be properly protected during construction to prevent water intrusion into the building. Protective measures could include temporary covers and plugs, as well as other appropriate temporary elements.

1.8 PRIOR APPROVALS

- A. Manufacturers References: When reference is made in the Contract Documents to trade names or specific manufacturers and/or models, such reference, unless noted otherwise, is made to designate and identify the quality of materials or equipment to be furnished and is not intended to restrict competitive bidding. If it is desired to use materials or equipment different from those indicated on the Contract Documents, written request for approval must be received by the Architect at least TEN DAYS prior to the date set for the opening of bids. A copy of the request should also be sent directly to the Engineer. Requests for prior approval of a proposed substitute shall be accompanied by complete technical data supporting the request.
- B. Request for Prior Approval by facsimile transmission (fax) will not be considered. Prior approval requests shall be submitted in hard copy or email format only.

1.9 PERMITS AND FEES

- A. Obtain all necessary Permits and Inspections required for the installation of this work and pay all charges incident thereto. Deliver to the Architect all certificates of inspection issued by authorities having jurisdiction.
- B. Sewer tap fees, water tap fees, meter fees, Dept. of Labor Fees for Boilers and Pressure Vessels and all other charges for work under Division 23, including charges for meter installation and excess service by the Gas Company or any other utilities shall be paid by the Contractor.

1.10 SAFETY

- A. OSHA Requirements applicable to the project shall be complied with at all times.
- B. Manufacturer's Safety Instructions shall be followed in all instances.
- C. Asbestos Containing Materials (ACM) shall not be used on this project.
- D. Refrigerants containing CFC's or HCFS's shall not be used on this project, nor shall any equipment using such refrigerants be incorporated into this project.
- E. Guards shall be provided where appliances, equipment, fans or other components that require service are located within 10 feet of a roof edge or open side of a walking surface and such edge or open side is located more than 30 inches above the floor, roof or grade below. The guard shall extend not less than 30 inches beyond each end of such appliances, equipment, fans, components and roof hatch openings and the top of the guard shall be located not less than 42 inches above the elevated surface adjacent to the guard. The guard shall be constructed so as to prevent the passage of a 21-inch diameter sphere and shall comply with the loading requirements for guards specified in the International Building Code.

1.11 ENVIRONMENT

- A. Refrigerants containing CFC's or HCFS's shall not be used on this project, nor shall any equipment using such refrigerants be incorporated into this project.

1.12 FIELD CONDITIONS

- A. Electrical Equipment Clearances: Piping, equipment and other mechanical installations shall not be located within 42" of the front or 36" of the side of any electrical switchboards, panelboards, power panels, motor control centers, electrical transformers or similar electrical equipment. Piping and ductwork shall not pass through or above electrical equipment rooms except as required to serve those rooms.
- B. Layout:
 - 1. The equipment listed on the Drawings is considered basis of design equipment and has been used for the physical arrangement of the mechanical systems. When other equipment listed in the specifications as acceptable, equal or equipment which has received "prior approval" is used, it shall be the Contractor's responsibility to provide structural, ductwork, electrical, service clearances, or other changes required to accommodate the substituted equipment. Changes to use non basis of design equipment shall be made at no additional cost to the Owner. Submit a list of required changes along with all prior approval requests and shop drawing submittals.
 - 2. The Contract Drawings are intended to show the general arrangement of all mechanical work. They do not show in detail all offsets, fittings and transitions. Examine Drawings, investigate site conditions to be encountered and arrange work accordingly. Furnish all offsets and transitions required for a complete and functional installation.
 - 3. Drawings do not indicate in detail exact configuration of connections for fixtures, equipment and accessories. Final connection shall be as shown on approved Manufacturer's Submittal Drawings. Where Manufacturer's Submittal Drawings conflict with the Contract Documents, consult with the Architect for resolution.
- C. Measurement of Drawings by scale shall not be used as dimensions for fabrication. Measurements for locating fixtures, equipment, ductwork, piping and other mechanical items shall be made on the site and shall be based on actual job site conditions.
- D. Check spatial limitations and verify electrical requirements before ordering any mechanical equipment or materials. Before ordering materials or fabricating ductwork and piping, notify Architect if conflicts are detected with other building components. Place large equipment inside the building prior to the erection of exterior walls where equipment cannot enter finished building openings.
- E. Coordination: Mechanical work shall be coordinated with that of other trades to avoid conflict. The Contractor shall study all plans and specifications for this project and shall notify the Architect of any conflict between work under Division 23 and work under other divisions of the Project. Particular attention shall be given to interference between piping, electrical installations, structural systems, building openings and ductwork.
- F. Failure to accurately and timely coordinate with other trades for installation of mechanical systems shall not result in additional charges to the owner, architect or engineer.

1.13 CODES AND STANDARDS

- A. Mechanical installations shall conform to the latest edition or the addition approved by the authority having jurisdiction of the following, in addition to any other mentioned Codes and Standards.
 - 1. The International Building Code.
 - 2. The International Mechanical Code.
 - 3. The International Plumbing Code
 - 4. The State Energy Code
 - 5. The International Fire Protection Code
 - 6. NFPA Standard 13, Installation of Sprinkler Systems.
 - 7. NFPA Standard 70, National Electric Code.
 - 8. NFPA Standard 90A, Installation of Air Conditioning and Ventilation Systems.
 - 9. NFPA Standard 101, Code for Safety to Life for Fire in Buildings and Structures.

1.14 USE OF MEHCANICAL SYSTEMS DURING CONSTRUCTION

- A. The operation of the permanent HVAC systems during the construction process is strongly discouraged. However, the Contractor may take measures to protect the systems from contamination if they are operated.
- B. Under no circumstances shall the HVAC system be operated while sanding of any kind is taking place on the jobsite.
- C. When placed in operation during the construction period, all HVAC systems shall have MERV 8 filtration in all standard filter racks throughout the systems. Where so equipped, final filter banks do not have to be in place.
- D. All return openings and outdoor air intake openings shall be protected with MERV 8 filter material at all points of entry into the duct system. These protections shall be maintained and remain in place until the building is prepared for final inspection. Failure to comply will result in contractor being required to clean ductwork prior to final acceptance.
- E. The interior of all HVAC units shall be thoroughly cleaned to “like-new” condition prior to final acceptance of the building HVAC systems. New, clean filters shall be furnished in all new equipment.

1.15 INTERRUPTION OF EXISTING SERVICES

- A. Exercise care so as not to cut any existing utilities or services. Where an existing utility line or service line is cut it shall be repaired to "like-new" condition. Interruption of service shall not be made without prior written permission of the Owner.

PART 2 - PRODUCTS (Not applicable for this section.)

PART 3 - EXECUTION (Not applicable for this section.)

END OF SECTION 230000

SECTION 230500 - BASIC MECHANICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.

1.2 SUMMARY

- A. Section includes the following basic mechanical materials and methods to complement other mechanical sections.
 1. Non-shrink grout for equipment installations.
 2. Fire stopping.
 3. Installation requirements common to equipment specification sections.
 4. Touchup painting and finishing.
 5. Concrete equipment base construction requirements.
 6. Cutting and Patching.
- B. See individual piping sections for pipe and pipe fitting materials.

1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

1.4 SUBMITTALS

- A. General: Submit the following according to the Conditions of the Contract.

1.5 QUALITY ASSURANCE

- A. Equipment Selection: Equipment of greater or larger power, dimensions, capacities, and ratings may be furnished provided such proposed equipment is approved in writing and connecting mechanical and electrical services, circuit breakers, conduit, motors, bases, and equipment spaces are increased. No additional costs will be approved for these increases, if larger equipment is approved. If minimum energy ratings or efficiencies of the equipment are specified, the equipment must meet the design requirements and commissioning requirements.
- B. Coordinate all electrical service requirements for mechanical equipment prior to the submittal of shop drawings. Confirm the compatibility of all power services with the equipment being furnished. Confirm compatibility of electrical lugs being provided by the equipment manufacturer with the power wiring being furnished under Division 26. Furnish written documentation that all characteristics have been coordinated with and confirmed by the electrical subcontractor.

1.6 SEQUENCING AND SCHEDULING

- A. Coordinate mechanical equipment installation with other building components.
- B. Arrange for chases, slots, and openings in building structure during progress of construction to allow for mechanical installations.
- C. Coordinate the installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
- D. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work. Coordinate installation of large equipment requiring positioning prior to closing in the building.
- E. Coordinate connection of electrical services.
- F. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies.
- G. Coordinate requirements for access panels and doors where mechanical items requiring access are concealed behind finished surfaces.
- H. Coordinate installation of identifying devices after completing covering and painting where devices are applied to surfaces. Install identifying devices prior to installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 GROUT

- A. Nonshrink, Nonmetallic Grout: ASTM C 1107, Grade B.
 - 1. Characteristics: Post-hardening, volume-adjusting, dry, hydraulic-cement grout, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.
 - 3. Packaging: Premixed and factory-packaged.

2.2 FIRE STOPPING

- A. Fire-Resistant Sealant: Provide UL Listed firestopping system for filling openings around penetrations through walls and floors, having fire-resistance ratings indicated as established by testing identical assemblies per ASTM E 814 by Underwriters Laboratory, Inc. or other testing and inspecting agency acceptable to authorities having jurisdiction.
- B. Products: Subject to compliance with requirements, provide products by one of the following:
 - 1. Dow Corning Corp.
 - 2. 3M Corporation
 - 3. General Electric Co.
 - 4. Standard Oil Engineered Materials Co.
 - 5. Hilti, Inc.
 - 6. Tremco Corp.

PART 3 - EXECUTION

3.1 GROUTING

- A. Install nonmetallic nonshrink grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors. Mix grout according to manufacturer's printed instructions.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms for placement of grout, as required.
- D. Avoid air entrapment when placing grout.
- E. Place grout to completely fill equipment bases.
- F. Place grout on concrete bases to provide a smooth bearing surface for equipment.
- G. Place grout around anchors.

- H. Cure placed grout according to manufacturer's printed instructions.

3.2 FIRESTOPPING

- A. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials

3.3 COMMON INSTALLATION REQUIREMENTS

- A. General Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate general location and arrangement of mechanical systems. Indicated locations and arrangements were used to size ductwork and pipe; and calculate friction loss, expansion, pump sizing, and other design considerations. Install ductwork and piping as indicated, except where deviations to layout are approved on coordination drawings.
- B. Install equipment to provide the maximum possible headroom where mounting heights are not indicated.
- C. Install equipment according to approved submittal data. Portions of the Work are shown only in diagrammatic form. Refer conflicts to the Architect.
- D. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, except where otherwise indicated.
- E. Install mechanical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. Connect equipment for ease of disconnecting, with minimum of interference with other installations. Extend grease fittings to an accessible location.
- F. Install equipment giving right-of-way to piping systems installed at a required slope.

3.4 PAINTING AND FINISHING

- A. Damage and Touch Up: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.
- B. Paint all exposed steel surfaces of piping and supports with one coat of primer and two coats of enamel.

3.5 CONCRETE BASES

- A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
 - 1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.

2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
7. Use 3000-psi, 28-day compressive strength concrete with 6 x 6 x #10 reinforcing wire mesh.
8. Outdoor concrete bases shall extend a minimum of 4" above grade and be a minimum thickness of 6".

END OF SECTION 230500

SECTION 230512 - MOTOR CONTROLLERS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.

1.2 SUMMARY

- A. Section includes ac motor control devices for mechanical equipment that are supplied as enclosed units.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include material descriptions, dimensions of individual components and profiles.
 - 2. Include rated capacities, operating characteristics, and furnished specialties and accessories.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: To include in maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Maintain, within 150 miles of Project site, a service center capable of providing training, parts, and emergency maintenance and repairs.
- B. Comply with NFPA 70.
- C. Comply with UL 508 and 508A
- D. Comply with NEMA ICS-2, 2000
- E. Comply with IEC 60947-5, 60947-4, 60947-3

- F. Listing and Labeling: Provide motor controllers specified in this Section that are listed and labeled.
 - 1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.

1.7 COORDINATION

- A. Coordinate features of controllers and accessory devices with pilot devices and control circuits to which they connect.
- B. Coordinate features, accessories, and functions of each motor controller with the ratings and characteristics of the supply circuit, the motor, the required control sequence, and the duty cycle of the motor and load.

1.8 WARRANTY

- A. Manufacturer shall provide a five-year warranty on the complete starter assembly for single phase starters and magnetic motor controllers

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide one of the following:
 - 1. Single Phase Starters and Magnetic Motor Controllers:
 - a. ABB
 - b. Allen-Bradley Co.; Industrial Control Group.
 - c. Cerus Industrial
 - d. Cutler-Hammer Products.
 - e. Danfoss Graham
 - f. General Electric
 - g. Siemens Energy & Automation, Inc.
 - h. Square D.

2.2 SINGLE PHASE STARTER

- A. Description: Starters for 115VAC single phase motors less than 1 HP shall be capable of both manual and automatic operation.
- B. NEMA ICS 2, general purpose, Class A.
- C. The single phase motor starter shall consist of a manually operated quick-make toggle mechanism lockable in the "Off" position which shall also function as the motor disconnect. Additionally, the starter shall provide thermal overload protection, run status pilot light and

fault pilot light. The starter must include the capability to operate in both manual and automatic control modes. In automatic mode, the starter shall have the capability to integrate with a building automation system by providing terminals for run input, run status output and fault output. All control terminals shall be integrated in the starter. At a minimum, each single phase starter shall include an interposing run relay and current sensing status output relay. Single phase motor starter shall be in a surface mount enclosure.

- D. Starters for single phase motors not automatically started shall be manual type with thermal protection.

2.3 MAGNETIC MOTOR CONTROLLERS

A. GENERAL

1. Combination starters shall be furnished for all three phase motors, (unless specifically noted otherwise) and single phase motors which are automatically started.
2. Starters shall be NEMA type and shall provide protection on all three phases.
3. Combination Starters: Provide combination magnetic starters for all motors requiring branch circuit protection or a line-of-sight disconnect in addition to starter.

B. ENCLOSED FULL VOLTAGE NON-REVERSING (FVNR) NON-COMBINATION STARTER

1. Magnetic Motor Starters shall be enclosed in a general purpose electrical enclosure with the appropriate environmental rating.
2. Starters shall consist of a horsepower rated magnetic contactor with a minimum of 2NO and 2NC auxiliary contacts and solid state electronic overload relay.
3. Overload relay shall protect all three phases with a wide range 1-40 amp current setting and trip class to allow field adjustment for specific motor FLA. Interchangeable heater elements are not acceptable.
4. Overload relay shall incorporate SmartStart Technology, or the following protective functions:
 - a. Out of calibration protection (if the FLA on the overload is set outside acceptable range, overload will trip to indicate fault event)
 - b. Stall protection
 - c. Max time to start
 - d. Locked Rotor
 - e. Phase Unbalance
 - f. Phase loss
 - g. Cycle Fault
5. Starter shall be field selectable for manual or auto reset to restore normal operation after a trip or fault condition. Manual pushbutton shall be accessible without removing or opening cover on starter.
6. In the event of a power failure, starter shall restart in last mode.
7. All starters must be provided with a universal power supply capable of a 208 to 600 volt input range. The power supply must accept the available line voltage and the control voltage shall not exceed 24V.
8. Installed accessories shall include Hand-Off-Auto operation pushbutton keypad. Include LED pilot light indicators for Hand, Off, Auto, Run and Overload conditions.

9. When remotely controlled by an automation system, the starter shall include remote run terminals which accept both a voltage input signal and a contact closure. The voltage run input shall accept both AC and DC signals from 12-250V to allow direct connection of the transistorized automation signal to the starter.
10. Starter must contain an integral current sensor with NO contact which closes to indicate motor run status as well as a NO contact which closes when an overload trip condition occurs.
11. Each starter shall have an individual control circuit transformer, line voltage primary, 120 volt secondary, with one fuse in the ungrounded side of the secondary. The transformer shall have 100% space capacity. Where electrical interlocking is involved, a separate contact on the circuit breaker disconnect shall open the interlock circuit. All sources of power to each combination starter shall be deenergized when the lockable circuit breaker disconnect is opened.

C. ENCLOSED FULL VOLTAGE NON-REVERSING (FVNR) COMBINATION STARTER

- A. Enclosed combination starters shall include all of the magnetic starter requirements in addition to a disconnecting method. All disconnects shall include a lock-out mechanism when in the off position.
- B. Motor circuit protectors (MCP) shall be provided as the acceptable form of disconnecting means. The MCP shall be a UL listed 508 current limiting manual motor starter with magnetic trip elements only. The MCP shall carry a UL 508F rating (up to 100A frame size) which provides for coordinated short circuit rating for use with the motor contactor and provides a minimum interrupting rating of 30,000 AIC for the combination starter.

2.4 ENCLOSURES

- A. Description: Flush or surface-mounted cabinets as indicated. NEMA 250, Type 1, unless otherwise indicated to meet environmental conditions at installed location.
 1. Outdoor Locations: NEMA 250, Type 3R.
 2. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
 3. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7C.

2.5 ACCESSORIES

- A. Devices are factory installed in controller enclosure, unless otherwise indicated.
- B. Pilot Lights and "Hand-Off-Auto" Selector Switches: NEMA ICS 2, heavy-duty type.
- C. Stop and Lockout Push-Button Station: Momentary-break push-button station with a factory-applied hasp arranged so a padlock can be used to lock push button in depressed position with control circuit open.
- D. Factory mounted with Nationally Recognized Testing Laboratory listed and labeled mounting device.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Select features of each motor controller to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; duty cycle of motor, drive, and load; and configuration of pilot device and control circuit affecting controller functions.
- B. Select horsepower rating of controllers to suit motor controlled.
- C. Push-Button Stations: In covers of magnetic controllers for manually started motors where indicated, start contact connected in parallel with sealing auxiliary contact for low-voltage protection.
- D. Hand-Off-Automatic Selector Switches: In covers of controllers of motors started and stopped by automatic controls or interlocked with other equipment. Also, furnish "run" light in cover.

3.2 GENERAL INSTALLATION

- A. Install independently mounted motor-control devices according to manufacturer's written instructions.
- B. Location: Locate controllers within sight of motors controlled, unless otherwise indicated.
- C. For control equipment at walls, bolt units to wall or mount on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks conforming to Division 26 Sections.
- D. Motor-Controller Fuses: Install indicated fuses in each fusible switch.

3.3 CONTROL WIRING INSTALLATION

- A. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters. Conceal raceway and cables except in unfinished spaces.
 - 1. Comply with requirements for cable trays specified in Section "Cable Trays for Electrical Systems."
 - 2. Comply with requirements for raceways and boxes specified in Section "Raceways and Boxes for Electrical Systems."
- B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
- C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
- D. Connect hand-off-automatic switch and other automatic control devices where available.

1. Connect selector switches to bypass only the manual and automatic control devices that have no safety functions when switch is in the hand position.
2. Connect selector switches with motor-control circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, fire-related cutouts and motor overload protectors.

3.4 IDENTIFICATION

- A. Identify motor-control components and control wiring according to other Division 23 Sections.

3.5 STARTUP SERVICE

- A. Testing: After installing motor controllers and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.
 1. Procedures: Perform each visual and mechanical inspection and electrical test stated in NETA ATS, Sections 7.5, 7.6, and 7.16. Certify compliance with test parameters.
 2. Remove and replace malfunctioning units with new units, and retest.

3.6 ADJUSTING

- A. Tighten connectors, terminals, bus joints, and mountings. Tighten field-connected connectors and terminals, including screws and bolts, according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.7 CLEANING

- A. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish. Clean devices internally, using methods and materials recommended by manufacturer.

3.8 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 230512

SECTION 230513 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.

1.2 SUMMARY

- A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.3 COORDINATION

- A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
 - 1. Motor controllers.
 - 2. Torque, speed, and horsepower requirements of the load.
 - 3. Ratings and characteristics of supply circuit and required control sequence.
 - 4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

- A. Comply with NEMA MG 1 unless otherwise indicated.
- B. Comply with IEEE 841 for severe-duty motors.

2.2 MOTOR CHARACTERISTICS

- A. Duty: Continuous duty at ambient temperature of 104 deg F and at altitude of 3300 feet above sea level.
- B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 POLYPHASE MOTORS

- A. Description: NEMA MG 1, Design B, medium induction motor.
- B. Efficiency: Energy efficient, as defined in NEMA MG 1.
- C. Service Factor: 1.15.
- D. Multispeed Motors: Variable torque.
 - 1. For motors with 2:1 speed ratio, consequent pole, single winding.
 - 2. For motors with other than 2:1 speed ratio, separate winding for each speed.
- E. Multispeed Motors: Separate winding for each speed.
- F. Rotor: Random-wound, squirrel cage.
- G. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
- H. Temperature Rise: Match insulation rating.
- I. Insulation: Class F .
- J. Code Letter Designation:
 - 1. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.
- K. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

- A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
- B. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

2.5 SINGLE-PHASE MOTORS

- A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
 - 1. Permanent-split capacitor.
 - 2. Split phase.
 - 3. Capacitor start, inductor run.
 - 4. Capacitor start, capacitor run.
- B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.

- C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
- D. Motors 1/20 HP and Smaller: Shaded-pole type.
- E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 230513

SECTION 230517 - SLEEVES AND SLEEVE SEALS FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Sleeves.
 - 2. Grout.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.1 SLEEVES

- A. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.

2.2 GROUT

- A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Nonshrink; recommended for interior and exterior applications.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.
 - 1. Sleeves are not required for core-drilled holes.
- C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
 - 1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
 - 2. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.
 - 3. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.
- D. Install sleeves for pipes passing through interior partitions.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - 2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
 - 3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Section "Joint Sealants."
- E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in other Sections.

3.2 SLEEVE AND SLEEVE-SEAL SCHEDULE

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
 - 1. Exterior Concrete and Masonry Walls above Grade:
 - a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.
 - 2. Interior Concrete or Masonry Partitions:
 - a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.

END OF SECTION 230517

SECTION 230518 - ESCUTCHEONS FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Escutcheons.

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

- A. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.
- B. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
- B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
 - 1. Escutcheons for New Piping:
 - a. Insulated Piping: One-piece, stamped-steel type.
 - b. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
 - c. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
 - d. Bare Piping in Unfinished Service and Equipment room Spaces: One-piece, cast-brass finish.

3.2 FIELD QUALITY CONTROL

- A. Replace broken and damaged escutcheons using new materials.

END OF SECTION 230518

SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.
2. Thermal-hanger shield inserts.
3. Fastener systems.
4. Equipment supports.

B. Related Sections:

1. Section "Vibration Controls for HVAC" for vibration isolation devices.
2. Section "Metal Ducts" for duct hangers and supports.

1.3 DEFINITIONS

- A. MSS: Manufacturers Standardization Society of the Valve and Fittings Industry Inc.

1.4 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
 1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
 2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

- B. Shop Drawings: Show fabrication and installation details and include calculations for the following; include Product Data for components:

- 1. Equipment supports.

1.6 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.7 QUALITY ASSURANCE

- A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

- A. Carbon-Steel Pipe Hangers and Supports:

- 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
- 2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
- 3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
- 4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
- 5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

2.2 THERMAL-HANGER SHIELD INSERTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- 1. Carpenter & Paterson, Inc.
- 2. Clement Support Services.
- 3. ERICO International Corporation.
- 4. National Pipe Hanger Corporation.
- 5. PHS Industries, Inc.
- 6. Pipe Shields Inc.
- 7. Piping Technology & Products, Inc.
- 8. Rilco Manufacturing Co., Inc.
- 9. Value Engineered Products, Inc.

- B. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.
- C. Insulation-Insert Material for Hot Piping: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength.
- D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- F. Insert Length: Extend 2 inches minimum or 2 ½ times the pipe diameter beyond sheet metal shield for piping operating below ambient air temperature.

2.3 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
- B. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.4 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.5 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.
- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
 1. Properties: Nonstaining, noncorrosive, and nongaseous.
 2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- B. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- C. Fastener System Installation:
 - 1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
 - 2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- D. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- E. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- F. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- G. Install lateral bracing with pipe hangers and supports to prevent swaying.
- H. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- I. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- J. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- K. Insulated Piping:
 - 1. Attach clamps and spacers to piping.
 - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
4. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
 - b. NPS 4: 12 inches long and 0.06 inch thick.
 - c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
 - d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
 - e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make bearing surface smooth.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 2. Obtain fusion without undercut or overlap.
 3. Remove welding flux immediately.

4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.5 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.
- B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.6 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use carbon-steel pipe hangers and supports and attachments for general service applications.
- F. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.
- G. Use padded hangers for piping that is subject to scratching.
- H. Use thermal-hanger shield inserts for insulated piping and tubing.
- I. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
 2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F, pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
 3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
 4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
 5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
 6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.
 7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
 8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
 9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
 10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.
 11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.
 12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
 13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
 14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
 15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
 16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
 17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
 18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.
 19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
 20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
 21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.
- J. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.
- K. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
 3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
 4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
 5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.
- L. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 6. C-Clamps (MSS Type 23): For structural shapes.
 7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
 10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
 11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb.
 - b. Medium (MSS Type 32): 1500 lb.
 - c. Heavy (MSS Type 33): 3000 lb.
 13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
 15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
- M. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- N. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
 2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
 3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
 4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
 5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
 6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
 7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
 8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
 - a. Horizontal (MSS Type 54): Mounted horizontally.
 - b. Vertical (MSS Type 55): Mounted vertically.
 - c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.
- O. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- P. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.
- Q. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION 230529

SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Equipment labels.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

1.4 COORDINATION

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

- A. Plastic Labels for Equipment:
 - 1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
 - 2. Letter Color: White.
 - 3. Background Color: Black.

4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
 5. Minimum Label Size: Length and width vary for required label content.
 6. Minimum Letter Size: 1/4 inch
 7. Fasteners: Stainless-steel rivets.
 8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Label Content: Include equipment's Drawing designation or unique equipment number .
- C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

END OF SECTION 230553

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Balancing Air Systems:
 - a. Constant-volume air systems.
 - 2. Testing, Adjusting, and Balancing Equipment:
 - a. Motors.
 - b. Condensing units.
 - c. Heat-transfer coils.
 - 3. Control system verification.

1.3 DEFINITIONS

- A. AABC: Associated Air Balance Council.
- B. BAS: Building automation systems.
- C. NEBB: National Environmental Balancing Bureau.
- D. TAB: Testing, adjusting, and balancing.
- E. TABB: Testing, Adjusting, and Balancing Bureau.
- F. TAB Specialist: An entity engaged to perform TAB Work.
- G. TDH: Total dynamic head.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: Within 30 days of Contractor's Notice to Proceed, submit documentation that the TAB contractor and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

- B. Contract Documents Examination Report: Within 45 days of Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3.
- C. Strategies and Procedures Plan: Within 60 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article in Part 3.
- D. Sample report forms.
- E. Instrument calibration reports, to include the following:
 - 1. Instrument type and make.
 - 2. Serial number.
 - 3. Application.
 - 4. Dates of use.
 - 5. Dates of calibration.
- F. Certified TAB reports: as specified in "Final Report" Article in Part 3.

1.5 QUALITY ASSURANCE

- A. TAB Contractor Qualifications: Engage a TAB entity certified by AABC.
 - 1. TAB Field Supervisor: Employee of the TAB contractor and certified by AABC .
 - 2. TAB Technician: Employee of the TAB contractor and who is certified by AABC as a TAB technician.
- B. Certify TAB field data reports and perform the following:
 - 1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
 - 2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.
- C. TAB Report Forms: Use standard TAB contractor's forms certified by the test and balance agent.
- D. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."
- E. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."
- F. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."

1.6 PROJECT CONDITIONS

- A. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.7 COORDINATION

- A. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.
- B. Perform TAB after leakage and pressure tests on air distribution systems have been satisfactorily completed.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Contract Document Review:
 - 1. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment. Notify Architect of any such conditions.
 - 2. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are accessible. Notify Architect if any devices are found to be in inaccessible locations.
 - 3. Examine the approved submittals for HVAC systems and equipment. Notify Architect of any discrepancies found between design contract documents and approved submittals.
- B. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.
- C. Examine ceiling plenums and underfloor air plenums used for supply, return, or relief air to verify that they meet the leakage class of connected ducts as specified in Section "Metal Ducts" and/ or Section "Nonmetal Ducts" and are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.
- D. Examine equipment performance data including fan and pump curves.
 - 1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
 - 2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.
- E. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
- F. Examine test reports specified in individual system and equipment Sections.

- G. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.
- H. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- I. Examine operating safety interlocks and controls on HVAC equipment.
- J. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

- A. Prepare a TAB plan that includes strategies and step-by-step procedures.
- B. Perform system-readiness checks of HVAC systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:
 - 1. General:
 - a. Permanent electrical-power wiring is complete.
 - b. Automatic temperature-control systems are operational.
 - c. Equipment and duct access doors are securely closed.
 - d. Windows and doors can be closed so indicated conditions for system operations can be met.
 - 2. Airside:
 - a. Verify that leakage and pressure tests on air distribution systems have been satisfactorily completed.
 - b. Duct systems are complete with terminals installed.
 - c. Volume, smoke, and fire dampers are open and functional.
 - d. Clean filters are installed.
 - e. Fans are operating, free of vibration, and rotating in correct direction.
 - f. Automatic temperature-control systems are operational.
 - g. Ceilings are installed.
 - h. Suitable access to balancing devices and equipment is provided.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance" and SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing" and in this Section.
- B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.
 - 1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.

2. After testing and balancing, install test ports and duct access doors that comply with requirements in Section 233300 "Air Duct Accessories."
 3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section "Duct Insulation," Section "HVAC Equipment Insulation," and Section "HVAC Piping Insulation."
- C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.
- D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.
- B. Prepare schematic diagrams of systems' "as-built" duct layouts.
- C. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.
- D. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.
- E. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- F. Verify that motor starters are equipped with properly sized thermal protection.
- G. Check dampers for proper position to achieve desired airflow path.
- H. Check for airflow blockages.
- I. Check condensate drains for proper connections and functioning.
- J. Check for proper sealing of air-handling-unit components.
- K. Verify that air duct system is sealed as specified in Section "Metal Ducts."

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
 1. Measure total airflow.
 - a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
 - b. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.

- c. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
 - d. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.
 - 2. Measure fan static pressures as follows to determine actual static pressure:
 - a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
 - b. Measure static pressure directly at the fan outlet or through the flexible connection.
 - c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.
 - d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
 - 3. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
 - a. Report the cleanliness status of filters and the time static pressures are measured.
 - 4. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.
 - 5. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
 - 6. Obtain approval from Engineer for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
 - 7. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.
- B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.
- 1. Measure airflow of submain and branch ducts.
 - a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
 - 2. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.
 - 3. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.
- C. Measure air outlets and inlets without making adjustments.

1. Set airflow patterns of adjustable outlets for proper distribution without drafts.
2. Measure inlets and outlets airflow.
3. Adjust each inlet and outlet for specified airflow.
4. Re-measure each inlet and outlet after they have been adjusted.

D. Verify final system conditions.

1. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to design if necessary.
2. Re-measure and confirm that total airflow is within design.
3. Re-measure all final fan operating data, rpms, volts, amps, and static profile.
4. Mark all final settings.
5. Test system in economizer mode. Verify proper operation and adjust if necessary.
6. Measure and record all operating data.
7. Record final fan-performance data.

3.6 PROCEDURES FOR MOTORS

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer's name, model number, and serial number.
2. Motor horsepower rating.
3. Motor rpm.
4. Efficiency rating.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter thermal-protection-element rating.

3.7 PROCEDURES FOR CONDENSING UNITS

- A. Verify proper rotation of fans.
- B. Measure entering- and leaving-air temperatures.
- C. Record compressor data.

3.8 PROCEDURES FOR HEAT-TRANSFER COILS

A. Measure, adjust, and record the following data for each electric heating coil:

1. Nameplate data.
2. Airflow.
3. Entering- and leaving-air temperature at full load.
4. Voltage and amperage input of each phase at full load and at each incremental stage.
5. Calculated kilowatt at full load.
6. Fuse or circuit-breaker rating for overload protection.

B. Measure, adjust, and record the following data for each refrigerant coil:

1. Dry-bulb temperature of entering and leaving air.
2. Wet-bulb temperature of entering and leaving air.
3. Airflow.
4. Air pressure drop.
5. Refrigerant suction pressure and temperature.

3.9 CONTROLS VERIFICATION

- A. In conjunction with system balancing, perform the following:
1. Verify temperature control system is operating within the design limitations.
 2. Confirm that the sequences of operation are in compliance with Contract Documents.
 3. Verify that controllers are calibrated and function as intended.
 4. Verify that controller set points are as indicated.
 5. Verify the operation of lockout or interlock systems.
 6. Verify the operation of valve and damper actuators.
 7. Verify that controlled devices are properly installed and connected to correct controller.
 8. Verify that controlled devices travel freely and are in position indicated by controller: open, closed, or modulating.
 9. Verify location and installation of sensors to ensure that they sense only intended temperature, humidity, or pressure.
- B. Reporting: Include a summary of verifications performed, remaining deficiencies, and variations from indicated conditions.

3.10 TOLERANCES

- A. Set HVAC system's air flow rates and water flow rates within the following tolerances:
1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.
 2. Air Outlets and Inlets: Plus or minus 10 percent.

3.11 FINAL REPORT

- A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
 2. Include a list of instruments used for procedures, along with proof of calibration.
- B. Final Report Contents: In addition to certified field-report data, include the following:
1. Fan curves.
 2. Manufacturers' test data.
 3. Field test reports prepared by system and equipment installers.
 4. Other information relative to equipment performance; do not include Shop Drawings and product data.

- C. General Report Data: In addition to form titles and entries, include the following data:
1. Title page.
 2. Name and address of the TAB contractor.
 3. Project name.
 4. Project location.
 5. Architect's name and address.
 6. Engineer's name and address.
 7. Contractor's name and address.
 8. Report date.
 9. Signature of TAB supervisor who certifies the report.
 10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
 11. Summary of contents including the following:
 - a. Indicated versus final performance.
 - b. Notable characteristics of systems.
 - c. Description of system operation sequence if it varies from the Contract Documents.
 12. Nomenclature sheets for each item of equipment.
 13. Data for terminal units, including manufacturer's name, type, size, and fittings.
 14. Notes to explain why certain final data in the body of reports vary from indicated values.
 15. Test conditions for fans and pump performance forms including the following:
 - a. Settings for outdoor-, return-, and exhaust-air dampers.
 - b. Conditions of filters.
 - c. Cooling coil, wet- and dry-bulb conditions.
 - d. Face and bypass damper settings at coils.
 - e. Fan drive settings including settings and percentage of maximum pitch diameter.
 - f. Inlet vane settings for variable-air-volume systems.
 - g. Settings for supply-air, static-pressure controller.
 - h. Other system operating conditions that affect performance.
- D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
1. Quantities of outdoor, supply, return, and exhaust airflows.
 2. Duct, outlet, and inlet sizes.
 3. Balancing stations.
 4. Position of balancing devices.
- E. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:
1. Unit Data:
 - a. Unit identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and unit size.
 - e. Manufacturer's serial number.

- f. Unit arrangement and class.
- g. Discharge arrangement.
- h. Sheave make, size in inches, and bore.
- i. Center-to-center dimensions of sheave, and amount of adjustments in inches.
- j. Number, make, and size of belts.
- k. Number, type, and size of filters.

2. Motor Data:

- a. Motor make, and frame type and size.
- b. Horsepower and rpm.
- c. Volts, phase, and hertz.
- d. Full-load amperage and service factor.
- e. Sheave make, size in inches, and bore.
- f. Center-to-center dimensions of sheave, and amount of adjustments in inches.

3. Test Data (Indicated and Actual Values):

- a. Total air flow rate in cfm.
- b. Total system static pressure in inches wg.
- c. Fan rpm.
- d. Discharge static pressure in inches wg.
- e. Filter static-pressure differential in inches wg.
- f. Outdoor airflow in cfm.
- g. Return airflow in cfm.
- h. Outdoor-air damper position.
- i. Return-air damper position.

F. Apparatus-Coil Test Reports:

1. Coil Data:

- a. System identification.
- b. Location.
- c. Coil type.
- d. Number of rows.
- e. Fin spacing in fins per inch o.c.
- f. Make and model number.
- g. Face area in sq. ft.
- h. Tube size in NPS.
- i. Tube and fin materials.
- j. Circuiting arrangement.

2. Test Data (Indicated and Actual Values):

- a. Air flow rate in cfm.
- b. Average face velocity in fpm.
- c. Air pressure drop in inches wg.
- d. Outdoor-air, wet- and dry-bulb temperatures in deg F.
- e. Return-air, wet- and dry-bulb temperatures in deg F.
- f. Entering-air, wet- and dry-bulb temperatures in deg F.

- g. Leaving-air, wet- and dry-bulb temperatures in deg F.
 - h. Refrigerant expansion valve and refrigerant types.
 - i. Refrigerant suction pressure in psig.
 - j. Refrigerant suction temperature in deg F.
- G. Electric-Coil Test Reports: For electric furnaces, duct coils, and electric coils installed in central-station air-handling units, include the following:
- 1. Unit Data:
 - a. System identification.
 - b. Location.
 - c. Coil identification.
 - d. Capacity in Btu/h.
 - e. Number of stages.
 - f. Connected volts, phase, and hertz.
 - g. Rated amperage.
 - h. Air flow rate in cfm.
 - i. Face area in sq. ft..
 - j. Minimum face velocity in fpm.
 - 2. Test Data (Indicated and Actual Values):
 - a. Heat output in Btu/h.
 - b. Air flow rate in cfm.
 - c. Air velocity in fpm.
 - d. Entering-air temperature in deg F.
 - e. Leaving-air temperature in deg F.
 - f. Voltage at each connection.
 - g. Amperage for each phase.
- H. Fan Test Reports: For supply, return, and exhaust fans, include the following:
- 1. Fan Data:
 - a. System identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and size.
 - e. Manufacturer's serial number.
 - f. Arrangement and class.
 - g. Sheave make, size in inches, and bore.
 - h. Center-to-center dimensions of sheave, and amount of adjustments in inches.
 - 2. Motor Data:
 - a. Motor make, and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches, and bore.

- f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
 - g. Number, make, and size of belts.
 - 3. Test Data (Indicated and Actual Values):
 - a. Total airflow rate in cfm.
 - b. Total system static pressure in inches wg.
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg.
 - e. Suction static pressure in inches wg.
- I. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:
 - 1. Report Data:
 - a. System and air-handling-unit number.
 - b. Location and zone.
 - c. Traverse air temperature in deg F.
 - d. Duct static pressure in inches wg.
 - e. Duct size in inches.
 - f. Duct area in sq. ft..
 - g. Indicated air flow rate in cfm.
 - h. Indicated velocity in fpm.
 - i. Actual air flow rate in cfm.
 - j. Actual average velocity in fpm.
 - k. Barometric pressure in psig.
- J. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:
 - 1. Unit Data:
 - a. System and air-handling-unit identification.
 - b. Location and zone.
 - c. Room or riser served.
 - d. Coil make and size.
 - e. Flowmeter type.
 - 2. Test Data (Indicated and Actual Values):
 - a. Air flow rate in cfm.
 - b. Entering-air temperature in deg F.
 - c. Leaving-air temperature in deg F.
- K. Instrument Calibration Reports:
 - 1. Report Data:
 - a. Instrument type and make.
 - b. Serial number.
 - c. Application.

- d. Dates of use.
- e. Dates of calibration.

3.12 ADDITIONAL TESTS

- A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.
- B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION 230593

SECTION 230713 - DUCT INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.

1.2 SUMMARY

- A. Section includes insulating the following duct services:
 - 1. Indoor, concealed supply, return, and outdoor air.
- B. Related Sections:
 - 1. Section "HVAC Piping Insulation."
 - 2. Section "Metal Ducts" for duct liners.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied if any).

1.4 QUALITY ASSURANCE

- A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section "Hangers and Supports for HVAC Piping and Equipment."
- B. Coordinate clearance requirements with duct Installer for duct insulation application. Before preparing ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.7 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Comply with requirements in "Duct Insulation Schedule, General," "Indoor Duct and Plenum Insulation Schedule," and "Aboveground, Outdoor Duct and Plenum Insulation Schedule" articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. CertainTeed Corp.; SoftTouch Duct Wrap.
 - b. Johns Manville; Microlite.
 - c. Knauf Insulation; Friendly Feel Duct Wrap.
 - d. Manson Insulation Inc.; Alley Wrap.
 - e. Owens Corning; SOFTR All-Service Duct Wrap.

- G. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide one of the following:

- a. CertainTeed Corp.; Commercial Board.
- b. Fibrex Insulations Inc.; FBX.
- c. Johns Manville; 800 Series Spin-Glas.
- d. Knauf Insulation; Insulation Board.
- e. Manson Insulation Inc.; AK Board.
- f. Owens Corning; Fiberglas 700 Series.

2.2 FIRE-RATED INSULATION SYSTEMS

- A. Fire-Rated Blanket: High-temperature, flexible, blanket insulation with FSK jacket that is tested and certified to provide a 2-hour fire rating by an NRTL acceptable to authorities having jurisdiction and UL Listed for rating on grease duct applications.

2.3 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

- B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Products: Subject to compliance with requirements, provide one of the following :

- a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.
- b. Eagle Bridges - Marathon Industries; 225.
- c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.
- d. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

- C. FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.4 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
 1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below ambient services.
 1. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
 2. Service Temperature Range: Minus 20 to plus 180 deg F.
 3. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
- C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
 1. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
 2. Service Temperature Range: Minus 20 to plus 180 deg F.
 3. Solids Content: 60 percent by volume and 66 percent by weight.

2.5 LAGGING ADHESIVES

- A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.
 1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct insulation.
 3. Service Temperature Range: 0 to plus 180 deg F.

2.6 SEALANTS

- A. FSK and Metal Jacket Flashing Sealants:
 1. Materials shall be compatible with insulation materials, jackets, and substrates.
 2. Fire- and water-resistant, flexible, elastomeric sealant.
 3. Service Temperature Range: Minus 40 to plus 250 deg F.
 4. Color: Aluminum.
 5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 6. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. PVC Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: White.
5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
6. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.7 FIELD-APPLIED FABRIC-REINFORCING MESH

- A. Woven Glass-Fiber Fabric: Approximately 6 oz./sq. yd. with a thread count of 5 strands by 5 strands/sq. in. for covering ducts.

2.8 FIELD-APPLIED CLOTHS

- A. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd..

2.9 SECUREMENTS

A. Bands:

1. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304; 0.015 inch thick, 3/4 inch wide.

B. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch diameter shank, length to suit depth of insulation indicated.
2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - a. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
 - b. Spindle: Copper- or zinc-coated, low-carbon steel, Aluminum, Stainless steel, fully annealed, 0.106-inch- diameter shank, length to suit depth of insulation indicated.

- c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
- 4. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - a. Baseplate: Perforated, nylon sheet, 0.030 inch thick by 1-1/2 inches in diameter.
 - b. Spindle: Nylon, 0.106-inch- diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches.
 - c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
- 5. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick, galvanized-steel, aluminum, stainless-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
 - a. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
- 6. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
- C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.
- D. Wire: 0.080-inch nickel-copper alloy, 0.062-inch soft-annealed, stainless steel or 0.062-inch soft-annealed, galvanized steel.

2.10 CORNER ANGLES

- A. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14.
- B. Stainless-Steel Corner Angles: 0.024 inch thick, minimum 1 by 1 inch, stainless steel according to ASTM A 167 or ASTM A 240/A 240M, Type 304.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
 - 1. Verify that systems to be insulated have been tested and are free of defects.
 - 2. Verify that surfaces to be insulated are clean and dry.

- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.
- B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Keep insulation materials dry during application and finishing.
- G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- H. Install insulation with least number of joints practical.
- I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
- J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- K. Install insulation with factory-applied jackets as follows:
 - 1. Draw jacket tight and smooth.
 - 2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.

3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
 - a. For below ambient services, apply vapor-barrier mastic over staples.
 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.
- L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.4 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
 4. Seal jacket to wall flashing with flashing sealant.
- C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

D. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves per the UL listing of the damper.

1. Comply with requirements in other Sections specifying firestopping and fire-resistive joint sealers.

E. Insulation Installation at Floor Penetrations:

1. Duct: For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve per the UL Listing of the damper.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in other Sections specifying penetration firestopping materials.

3.5 INSTALLATION OF MINERAL-FIBER INSULATION

A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 50 percent coverage of duct and plenum surfaces, or as recommended in manufacturer's printed instructions.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions, or as recommended in manufacturer's printed instructions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
 - b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d. Do not over compress insulation during installation.
 - e. Impale insulation over pins and attach speed washers.
 - f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
 - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.

- b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.
 - 5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
 - 6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
 - 7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.
- B. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
- 1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 50 percent coverage of duct and plenum surfaces.
 - 2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
 - 3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
 - b. On duct sides with dimensions larger than 18 inches, space pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d. Do not overcompress insulation during installation.
 - e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
 - 4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
 - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
 - b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.

5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.6 FIRE-RATED INSULATION SYSTEM INSTALLATION

- A. Where fire-rated insulation system is indicated, secure system to ducts and duct hangers and supports to maintain a continuous fire rating.
- B. Insulate duct access panels and doors to achieve same fire rating as duct.
- C. Install firestopping at penetrations through fire-rated assemblies. Fire-stop systems are specified in other Sections.

3.7 FINISHES

- A. Insulation with Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section "Exterior Painting" and Section "Interior Painting."
 1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
 - a. Finish Coat Material: Interior, flat, latex-emulsion size.
- B. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- C. Do not field paint aluminum or stainless-steel jackets.

3.8 DUCT INSULATION SCHEDULE, GENERAL

- A. Plenums and Ducts Requiring Insulation:
 1. Indoor, concealed: supply, return, and outdoor air, including lined duct.
 2. Above ceiling surfaces of all air devices.
- B. Items Not Insulated:
 1. Factory-insulated flexible ducts.
 2. Factory-insulated plenums and casings.
 3. Flexible connectors.
 4. Vibration-control devices.
 5. Factory-insulated access panels and doors.
 6. Transfer ducts.
 7. Exhaust duct serving toilets, janitors closets, and electrical rooms.

3.9 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

- A. All indoor insulation shall have a minimum R-value = 6.0.
- B. Concealed, rectangular, supply-air duct, outdoor air duct and return air duct insulation shall be the following:
 - 1. Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density.
1 ½ thick and 0.75-lb/cu. ft. nominal density may be used for lined duct.
 - 2. Seal all joints and penetrations in jacket with woven glass-fiber fabric and mastic.

END OF SECTION 230713

SECTION 230719 - HVAC PIPING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.

1.2 SUMMARY

A. Section includes insulating the following HVAC piping systems:

1. Condensate drain piping, indoors.
2. Refrigerant suction and hot-gas piping, indoors and outdoors.

B. Related Sections:

1. Section "Duct Insulation."

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).

1.4 QUALITY ASSURANCE

A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section "Hangers and Supports for HVAC Piping and Equipment."
- B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Coordinate installation and testing of heat tracing.

1.7 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.
 - 1. Products: Subject to compliance with requirements, provide one of the following
 - a. Aeroflex USA, Inc.; Aerocel.
 - b. Armacell LLC; AP Armaflex.
 - c. K-Flex USA; Insul-Lock, Insul-Tube, and K-FLEX LS.

2.2 INSULATING CEMENTS

- A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.
- B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C 196.
- C. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.

2.3 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
- B. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.
 - 1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- C. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
 - 1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- D. PVC Jacket Adhesive: Compatible with PVC jacket.
 - 1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.4 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
 - 1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.
 - 1. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.

2. Service Temperature Range: Minus 20 to plus 180 deg F.
3. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.

1. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
2. Service Temperature Range: Minus 20 to plus 180 deg F.
3. Solids Content: 60 percent by volume and 66 percent by weight.

2.5 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.

1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
3. Service Temperature Range: 0 to plus 180 deg F.

2.6 SEALANTS

A. Joint Sealants:

1. Joint Sealants for Cellular-Glass, and Polyisocyanurate Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
 - b. - Marathon Industries; 405.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-45.
 - d. Mon-Eco Industries, Inc.; 44-05.
 - e. Pittsburgh Corning Corporation; Pittseal 444.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Permanently flexible, elastomeric sealant.
4. Service Temperature Range: Minus 100 to plus 300 deg F.
5. Color: White or gray.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. FSK and Metal Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.

3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: Aluminum.
5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
6. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: White.
5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
6. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.7 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
 - 1) only if factory-fabricated fitting covers are not available.

2.8 SECUREMENTS

A. Bands:

1. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304; 0.015 inch thick, 3/4 inch wide.

B. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.

C. Wire: 0.080-inch nickel-copper alloy, 0.062-inch soft-annealed, stainless steel, or 0.062-inch soft-annealed, galvanized steel.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
 - 1. Verify that systems to be insulated have been tested and are free of defects.
 - 2. Verify that surfaces to be insulated are clean and dry.
 - 3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
 - 1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range between 140 and 300 deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
 - 2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
- C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.

- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:
 - 1. Draw jacket tight and smooth.
 - 2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 - 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
 - a. For below-ambient services, apply vapor-barrier mastic over staples.
 - 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
 - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.
- M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above-ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Manholes.
5. Handholes.
6. Cleanouts.
7. Flexible Connectors

3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
4. Seal jacket to wall flashing with flashing sealant.

C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

D. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.

1. Comply with requirements in Section "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

3.5 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
 2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
 3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
 4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
 5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
 6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
 7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
 8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
 9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.6 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

- A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- B. Insulation Installation on Pipe Flanges:
 1. Install pipe insulation to outer diameter of pipe flange.
 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
 4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- C. Insulation Installation on Pipe Fittings and Elbows:
 1. Install mitered sections of pipe insulation.
 2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- D. Insulation Installation on Valves and Pipe Specialties:
 1. Install preformed valve covers manufactured of same material as pipe insulation when available.
 2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 3. Install insulation to flanges as specified for flange insulation application.

4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.7 FIELD-APPLIED JACKET INSTALLATION

- A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.
 1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
 2. Embed glass cloth between two 0.062-inch- thick coats of lagging adhesive.
 3. Completely encapsulate insulation with coating, leaving no exposed insulation.
- B. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications. Seal with manufacturer's recommended adhesive.
 1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- C. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.8 FINISHES

- A. Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section "Exterior Painting" and Section "Interior Painting."
 1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
 - a. Finish Coat Material: Interior, flat, latex-emulsion size.
- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- D. Do not field paint aluminum or stainless-steel jackets.

3.9 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections.

- C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.10 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
 - 1. Condensate Drainage piping located in crawl spaces or outdoors.
 - 2. Underground piping.
 - 3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.11 INDOOR PIPING INSULATION SCHEDULE

- A. Condensate and Equipment Drain Water below 60 Deg F:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Flexible Elastomeric: 3/8 inch thick.
- B. Refrigerant Suction and Hot-Gas Piping and Tubing:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Flexible Elastomeric: 3/4 inch thick.

3.12 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

- A. Refrigerant Suction and Hot-Gas Piping and Tubing:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Flexible Elastomeric: 1 inch thick.

END OF SECTION 230719

SECTION 230900 - INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.

1.2 SUMMARY

- A. This Section includes control equipment for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-wired controls.
- B. Related Sections include the following:
 - 1. Section "Sequence of Operations for HVAC Controls" for requirements that relate to this Section.

1.3 ACTION SUBMITTALS

- A. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Bill of materials of equipment indicating quantity, manufacturer, and model number.
 - 2. Schematic flow diagrams showing fans, coils, dampers, and control devices.
 - 3. Wiring Diagrams: Power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer and manufacturer.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For HVAC instrumentation and control system to include in emergency, operation, and maintenance manuals. In addition to items specified in Section "Operation and Maintenance Data," include the following:
 - 1. Maintenance instructions and lists of spare parts for each type of control device.

2. Interconnection wiring diagrams with identified and numbered system components and devices.
3. Keyboard illustrations and step-by-step procedures indexed for each operator function.
4. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
5. Calibration records and list of set points.

B. Software and Firmware Operational Documentation: Include the following:

1. Software operating and upgrade manuals.
2. Program Software Backup: On a magnetic media or compact disc, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: control system manufacturer's authorized representative who is trained and approved for installation of system components required for this Project.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Manufacturer Qualifications: Engage a firm experienced in manufacturing control systems similar to those indicated for this Project and that have a record of successful in-service performance.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to equipment manufacturer.
- B. System Software: Update to latest version of software at Project completion.

1.8 COORDINATION

- A. Coordinate location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation.
- B. Coordinate equipment with Division 26 sections relating to Fire-Alarm Systems to achieve compatibility with equipment that interfaces with that system.

PART 2 - PRODUCTS

2.1 CONTROL SYSTEM

- A. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, and accessories to control mechanical systems.
- B. Power Supplies: Transformers with Class 2 current-limiting type or overcurrent protection; limit connected loads to 80 percent of rated capacity. UL recognized DC power supply shall match output current and voltage requirements and be full-wave rectifier type with the following:
 - 1. Output ripple of 5.0 mV maximum peak to peak.
 - 2. Combined 1 percent line and load regulation with 100-mic.sec. response time for 50 percent load changes.
 - 3. Built-in overvoltage and overcurrent protection and be able to withstand 150 percent overload for at least 3 seconds without failure.
- C. Power Line Filtering: Internal or external transient voltage and surge suppression for workstations or controllers with the following:
 - 1. Minimum dielectric strength of 1000 V.
 - 2. Maximum response time of 10 nanoseconds.
 - 3. Minimum transverse-mode noise attenuation of 65 dB.
 - 4. Minimum common-mode noise attenuation of 150 dB at 40 to 100 Hz.
- D. Relays:
 - 1. Control relays shall be UL listed plug-in type with dust cover. Contact rating, configuration and coil voltage suitable for application.
 - 2. Time delay relays shall be UL listed solid state plug-in type with adjustable time delay. Delay shall be adjustable plus or minus 200% (minimum) from set-point shown on plans. Contact rating, configuration and coil voltage suitable for application. Provide NEMA 1 Type enclosure when not installed in local control panel.

2.2 ELECTRONIC SENSORS

- A. Description: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.
- B. Room Sensor Cover Construction: Manufacturer's standard locking covers.
 - 1. Set-Point Adjustment: Exposed.
 - 2. Set-Point Indication: Exposed.
- C. Room sensor accessories include the following:
 - 1. Insulating Bases: For sensors located on exterior walls.
 - 2. Guards: Locking; heavy-duty, transparent plastic; mounted on separate base.

2.3 THERMOSTATS

- A. Combination Thermostat and Fan Switches: Line-voltage thermostat with push-button or lever-operated fan switch.
 - 1. Label switches "FAN ON-OFF".
 - 2. Mount on single electric switch box.
- B. Low-Voltage, On-Off Thermostats: NEMA DC 3, 24-V, bimetal-operated, mercury-switch type, with adjustable or fixed anticipation heater, concealed set-point adjustment, 55 to 85 deg F set-point range, and 2 deg F maximum differential.
- C. Fire-Protection Thermostats: Listed and labeled by an NRTL acceptable to authorities having jurisdiction; with fixed or adjustable settings to operate at not less than 75 deg F above normal maximum operating temperature, and the following:
 - 1. Reset: Manual.
- D. Programmable Thermostats:
 - 1. HVAC unit thermostats shall be manufacturer's standard electronic 7-day programmable model having an Off-Em-Ht.-Heat-Auto-Cool System switch and an Auto-On Fan switch. Provide multi-stage heating and cooling thermostat where controlled unit has multi-stage capability. Outdoor thermostat shall prevent strip heat from being energized above 45 degrees F. (Emergency heat position not required for non-heat pump unit.)
 - 2. System switching positions shall control thermostat operation as follows:
 - a. OFF - heating and cooling systems are off. If the fan switch is at the AUTO position, the cooling fan is also off.
 - b. HEAT - heating system is controlled by the thermostat. Cooling system is off.
 - c. AUTO - thermostat automatically switches between heat and cool modes, depending upon the indoor temperature.
 - d. COOL - thermostat controls the cooling system. Heating system if off.
 - e. EM.HT (Heat Pump Units Only) - emergency heat relay is energized on call for heat. Cooling system is off. Compressor is de-energized.
 - 3. Fan switching positions shall control fan operation as follows:
 - a. ON - fan operates continuously.
 - b. AUTO - fan operates as controlled by the thermostat in heat pump systems for conventional cooling mode; fan shall operate as controlled by plenum switch in conventional heating mode.
 - 4. Thermostat shall be furnished with the following features:
 - a. Override function.
 - b. Set up for four separate temperatures per day.
 - c. Battery replacement without program loss.
 - d. Proportional plus integral control.
 - e. Automatic changeover from cooling to heating.
 - f. Keypad lockout.
 - 5. Thermostat display features include the following:

- a. Time of day.
- b. Actual room temperature.
- c. Programmed temperature.
- d. Day of week.
- e. System mode indications include "heating," "off," "fan auto," and "fan on."

2.4 ACTUATORS

- A. Electric Motors: Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.
 - 1. Comply with requirements in Section "Common Motor Requirements for HVAC Equipment."
 - 2. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
 - 3. Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
 - 4. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running and breakaway torque of 150 in. x lbf.

- B. Electronic Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
 - 1. Dampers: Size for running torque calculated as follows:
 - a. Parallel-Blade Damper with Edge Seals: 7 inch-lb/sq. ft. of damper.
 - b. Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. of damper.
 - c. Parallel-Blade Damper without Edge Seals: 4 inch-lb/sq. ft. of damper.
 - d. Opposed-Blade Damper without Edge Seals: 3 inch-lb/sq. ft. of damper.
 - e. Dampers with 2- to 3-Inch wg of Pressure Drop or Face Velocities of 1000 to 2500 fpm: Increase running torque by 1.5.
 - f. Dampers with 3- to 4-Inch wg of Pressure Drop or Face Velocities of 2500 to 3000 fpm: Increase running torque by 2.0.
 - 2. Coupling: V-bolt and V-shaped, toothed cradle.
 - 3. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
 - 4. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on nonspring-return actuators.
 - 5. Power Requirements (Two-Position Spring Return): as required.
 - 6. Power Requirements (Modulating): Maximum 10 VA at 24-V ac or 8 W at 24-V dc.
 - 7. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
 - 8. Temperature Rating: Minus 22 to plus 122 deg F.
 - 9. Temperature Rating (Smoke Dampers): Minus 22 to plus 250 deg F.
 - 10. Run Time: 12 seconds open, 5 seconds closed.

2.5 DAMPERS

A. Manufacturers:

1. Air Balance Inc.
2. Don Park Inc.; Autodamp Div.
3. TAMCO (T. A. Morrison & Co. Inc.).
4. United Enertech Corp.
5. Vent Products Company, Inc.

B. Dampers: AMCA-rated, parallel or opposed-blade design; 0.108-inch- minimum thick, galvanized-steel or 0.125-inch- minimum thick, extruded-aluminum frames with holes for duct mounting; damper blades shall not be less than 0.064-inch- thick galvanized steel with maximum blade width of 8 inches and length of 48 inches.

1. Secure blades to 1/2-inch- diameter, zinc-plated axles using zinc-plated hardware, with nylon blade bearings, blade-linkage hardware of zinc-plated steel and brass, ends sealed against spring-stainless-steel blade bearings, and thrust bearings at each end of every blade.
2. Operating Temperature Range: From minus 40 to plus 200 deg F.
3. Edge Seals, Standard Pressure Applications: Closed-cell neoprene.
4. Edge Seals, Low-Leakage Applications: Use inflatable blade edging or replaceable rubber blade seals and spring-loaded stainless-steel side seals, rated for leakage at less than 10 cfm per sq. ft. of damper area, at differential pressure of 4-inch wg when damper is held by torque of 50 in. x lbf; when tested according to AMCA 500D.

2.6 SMOKE DETECTORS

A. Smoke detectors shall be located in the duct upstream of each smoke or combination fire/smoke damper. Detectors shall also be located on the wall adjacent to each smoke or combination fire/smoke damper located in plenum smoke partition.

B. In systems of over 2,000 cfm capacity smoke detectors approved for duct installation shall be installed at a suitable location in:

1. The return duct prior to the filters and prior to dilution by outdoor air.

C. Smoke detectors and duct housings shall be provided under Division 26. Detectors shall be compatible with existing fire alarm system and shall be approved by the Owner.

D. Detectors and duct housings used to activate smoke dampers and shut down air handlers shall be mounted under Division 23. Detectors shall be mounted in accordance with NFPA 72.

1. Sampling tubes shall extend full width of duct.
2. Provide access door at smoke detector.
3. Test/reset switches for smoke detectors are furnished and installed under Division 26.

2.7 SMOKE DAMPERS AND COMBINATION SMOKE AND FIRE DAMPERS

- A. Smoke dampers and combination smoke and fire dampers will be provided under Division 23. Control of dampers shall be under this section and in sequence of operation.
- B. A status panel for smoke dampers shall be provided in the ceiling below the individual dampers. Panel shall contain a red neon pilot light that shall be illuminated when damper is closed.
- C. Provide damper position interlock to ensure that smoke dampers are open 100% before unit fan is started.

2.8 CONTROL CABLE

- A. Electronic and fiber-optic cables for control wiring are specified in Division 26 Sections.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that power supply is available to control units. Where not indicated otherwise, obtain power for control units from the nearest un-switched receptacle circuit.
- B. Verify that all field end devices and wiring are installed before proceeding with installation.

3.2 INSTALLATION

- A. Install software in control units. Implement all features of programs to specified requirements and as appropriate to sequence of operation.
- B. Connect and configure equipment and software to achieve sequence of operation specified.
- C. Verify location of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation. Install devices 54 inches above the finished floor unless noted otherwise. Install wall thermostats minimum 8" away from door or window frames. Coordinate location with switches and other devices provided under other Divisions.
 - 1. Install averaging elements in ducts and plenums in crossing or zigzag pattern.
- D. Install guards on thermostats in the following locations:
 - 1. Entrances.
 - 2. Public areas.
 - 3. Where indicated.
- E. Install automatic dampers according to Section "Air Duct Accessories."
- F. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.

- G. Install labels and nameplates to identify control components according to Section "Identification for HVAC Piping and Equipment."
- H. Install refrigerant instrument wells, valves, and other accessories according to Section "Refrigerant Piping."
- I. Install duct volume-control dampers according to Section "Metal Ducts."
- J. Install electronic and fiber-optic cables according to Division 26."

3.3 ELECTRICAL WIRING AND CONNECTION INSTALLATION

- A. Install raceways, boxes, and cabinets according Division 26.
- B. Install building wire and cable according to Division 26.
- C. Install signal and communication according to Sections in division 26.
 - 1. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
 - 2. Route all wiring in plenum rated cable secured to structure.
 - a. Exception: All wiring associated with smoke detectors, smoke dampers, fire alarm shutdowns and similar systems shall be routed in conduit.
 - 3. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.
 - 4. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
 - 5. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.
 - 6. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.
- D. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.
- E. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

3.4 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 - 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.
 - 2. Test and adjust controls and safeties.
 - 3. Test each point through its full operating range to verify that safety and operating control set points are as required.
 - 4. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.

5. Test each system for compliance with sequence of operation.
6. Test software and hardware interlocks.

B. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

3.5 ADJUSTING

A. Calibrating and Adjusting:

1. Calibrate instruments.
2. Make three-point calibration test for both linearity and accuracy for each analog instrument.
3. Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.
4. Temperature:
 - a. Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span using a precision-resistance source.
 - b. Calibrate temperature switches to make or break contacts.
5. Stroke and adjust control dampers without positioners, following the manufacturer's recommended procedure, so that valve or damper is 100 percent open and closed.
6. Stroke and adjust control dampers with positioners, following manufacturer's recommended procedure, so that valve and damper is 0, 50, and 100 percent closed.
7. Provide diagnostic and test instruments for calibration and adjustment of system.
8. Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.

B. Adjust initial temperature and humidity set points.

3.6 DEMONSTRATION AND TRAINING

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC instrumentation and controls. Refer to Section "Demonstration and Training."
- B. Train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventive maintenance.
- C. Include a minimum of 4 hours dedicated instructor time on-site.
- D. Schedule training with Owner with at least 7 days' notice.

END OF SECTION 230900

SECTION 230993 - SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.

1.2 SUMMARY

- A. This Section includes control sequences for HVAC systems, subsystems, and equipment.
- B. Related Sections include the following:
 - 1. Section "Instrumentation and Control for HVAC" for control equipment and devices and for submittal requirements.

1.3 INFORMATIONAL SUBMITTALS

- A. General: Submit the following according to the Conditions of the Contract.
- B. Shop Drawings showing operating sequences of various equipment, devices, components, and materials included in the Text and defining the components' contribution to the system.

1.4 SMOKE DETECTORS AND SMOKE DAMPERS

- A. In systems with air handling capacity above 2,000 CFM and up to and including 15,000 CFM and all units serving egress corridors, the smoke detector mounted in the unit or main ductwork shall, when sensing smoke, shut down the Air Handling Unit. The smoke detectors shall be connected to the fire alarm system. The actuation of smoke detector shall activate a visible and supervisory signal at a constantly attended location. Where an outdoor condensing unit or heat pump is used it shall shut down those components.
- B. Smoke (or Combination) Damper/Smoke Detector: Upon sensing smoke at the detector, the damper shall close. When the damper is closed, the indicator light shall illuminate on the ceiling below the damper.

1.5 ENERGY CONSERVATION

- A. Dead Band: Where used to control both heating and cooling, zone thermostats shall be capable of providing a temperature dead band of at least 5°F in accordance with ASHRAE standard 90.1.

- B. All HVAC systems/units shall be scheduled for operation by the programmable thermostat. Coordinate the occupancy schedules with the Owner.
- C. In unoccupied mode, the temperature set point shall be set back to 50°F (adjustable) for heating 85°F (adjustable) for cooling. Units shall run only as required to maintain setback temperatures. Outside air dampers shall be closed during unoccupied mode where motorized dampers are indicated on the plans unless required for positive pressurization defined in other paragraphs of this section.
- D. HVAC systems shall energize to cool or warm the spaces to normal occupied setpoint in morning warm up/ cool down mode. Outside air dampers shall NOT be open during warm-up/cool-down mode where motorized dampers are indicated on the plans.
- E. Individual HVAC units shall be equipped with override features on unit thermostats. When the button is activated, the unit shall operate in occupied mode for a period determined by the Owner.

1.6 SAFETY SYSTEMS

- A. All Air-handling units shall deenergize on any general building fire alarm activation.
- B. An emergency air handling system shutdown switch shall be located adjacent to the main fire alarm panel. All air handling units shall de-energize whenever the master shutdown switch located at the main fire alarm panel is activated.

1.7 RELIABILITY AND GENERAL ALARM SYSTEMS

- A. Auto Restart: All HVAC systems and equipment shall be configured such that normal operation is resumed after a power failure.

1.8 UNITARY SYSTEMS

- A. Heat Pump Units:
 1. Units shall be controlled by programmable thermostats.
 2. Runtime of the unit shall be scheduled by the programmable thermostat.
 3. When unit is scheduled to run, the compressor, heat/cool reversing valve and supply fan shall energize in heating or cooling mode as required to satisfy the thermostat setpoint.
 4. When the compressor is unable to meet the heating requirements, the auxiliary strip heat shall energize.
 5. When outdoor air temperature is above 45°F (adj), resistance heat shall not be energized.
- B. Split Systems (ductless):
 1. Split systems shall be controlled by individual thermostats. Heating or cooling shall be energized as required to maintain space temperature.

1.9 DEDICATED OUTDOOR AIR (MAKEUP AIR) UNIT

- A. Unit shall operate in accordance with the system manufacturer's requirements, utilizing controllers furnished as part of the system. Unit shall operate when fume hood fan is operating. Refer to spec section 237433 for sequence.

1.10 VENTILATION SEQUENCES

- A. Exhaust Fan: See fan schedule on drawings.
 - 1. Where fans are indicated to be interlocked with room lighting, furnish starters/contactors as required for control operation.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 230993

SECTION 231126 - FACILITY LIQUEFIED-PETROLEUM GAS PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Pipes, tubes, and fittings.
 - 2. Piping specialties.
 - 3. Piping and tubing joining materials.
 - 4. Valves.
 - 5. Pressure regulators.
 - 6. Service meters.

1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. LPG: Liquefied-petroleum gas.

1.4 PERFORMANCE REQUIREMENTS

- A. Minimum Operating-Pressure Ratings:
 - 1. For Piping Containing Only Vapor:
 - a. Piping and Valves: 150 psig unless otherwise indicated.
 - 2. For Piping Containing Liquid:
 - a. Piping between Shutoff Valves: 350 psig unless otherwise indicated.
 - b. Piping Other Than Above: 250 psig unless otherwise indicated.

- c. Valves and Fittings: 250 psig unless otherwise indicated.
- 3. Minimum Operating Pressure of Service Meter: 5 psig.
- B. LPG System Pressure within Buildings: One pressure range. 0.5 psig or less
- C. LPG System Pressures within Buildings: Two pressure ranges. Primary pressure is more than 0.5 psig but not more than 2 psig and is reduced to secondary pressure of 0.5 psig or less.
- D. LPG System Pressures within Buildings: Two pressure ranges. Primary pressure is more than 2 psig but not more than 5 psig and is reduced to secondary pressure of more than 0.5 psig but not more than 2 psig.
- E. Delegated Design: Design restraints and anchors for LPG piping and equipment, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- F. Seismic Performance: Vaporizers and storage container supports shall withstand the effects of earthquake motions determined according to SEI/ASCE 7].
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of the following:
 - 1. Piping specialties.
 - 2. Corrugated stainless-steel tubing with associated components.
 - 3. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
 - 4. Pressure regulators. Indicate pressure ratings and capacities.
 - 5. Service meters. Indicate pressure ratings and] capacities. Include bypass fittings and meter bars.
 - 6. Dielectric fittings.
 - 7. Storage containers.
 - 8. Transport truck unloading specialties.
 - 9. Pumps.
 - 10. Vaporizers.
 - 11. Air mixers.
- B. Shop Drawings: For facility LPG piping layout. Include plans, piping layout and elevations, sections, and details for fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to building structure. Detail location of anchors, alignment guides, and expansion joints and loops.
 - 1. Detail mounting, supports, and valve arrangements for service meter assembly and pressure regulator assembly.

- C. Delegated-Design Submittal: For LPG piping and equipment indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - 1. Detail fabrication and assembly of seismic restraints.
 - 2. Design Calculations: Calculate requirements for selecting seismic restraints.

1.6 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plans and details, drawn to scale, on which LPG piping is shown and coordinated with other installations, using input from installers of the items involved.
- B. Site Survey: Plans, drawn to scale, on which LPG piping is shown and coordinated with other services and utilities.
- C. Qualification Data: For qualified professional engineer.
- D. Seismic Qualification Certificates: Submit certification that vaporizer, air mixer, storage container supports, accessories, and components will withstand seismic forces defined in Section 230548 "Vibration and Seismic Controls for HVAC." Include the following:
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- E. Welding certificates.
- F. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For LPG equipment and accessories to include in emergency, operation, and maintenance manuals.

1.8 QUALITY ASSURANCE

- A. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Handling Flammable Liquids: Remove and dispose of liquids from existing LPG piping according to requirements of authorities having jurisdiction.
- B. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- C. Store pipes and tubes with protective PE coating to avoid damaging coating and protect from direct sunlight.
- D. Protect stored PE pipes and valves from direct sunlight.

1.10 PROJECT CONDITIONS

- A. Perform site survey, research public utility records, and verify existing utility locations. Contact utility-locating service for area where Project is located.
- B. Interruption of Existing LPG Service: Do not interrupt LPG service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide purging and startup of LPG supply according to requirements indicated:
 - 1. Notify Architect] Construction Manager no fewer than two days in advance of proposed interruption of LPG service.
 - 2. Do not proceed with interruption of LPG service without Architect's] Construction Manager's Owner's written permission.

1.11 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.
- B. Coordinate requirements for access panels and doors for valves installed concealed behind finished surfaces. Comply with requirements in Section 083113 "Access Doors and Frames."

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

- A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedules 40 and 80, Type E or S, Grade B.
 - 1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
 - 2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.
 - 3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
 - 4. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

- a. Material Group: 1.1.
 - b. End Connections: Threaded or butt welding to match pipe.
 - c. Lapped Face: Not permitted underground.
 - d. Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum o-rings, and spiral-wound metal gaskets.
 - e. Bolts and Nuts: ASME B18.2.1, carbon steel aboveground, and stainless steel underground.
5. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.
- a. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.
6. Mechanical Couplings:
- a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) GE Oil & Gas.
 - 2) Smith-Blair, Inc.
 - b. [Stainless-steel] [Steel] flanges and tube with epoxy finish.
 - c. Buna-nitrile seals.
 - d. [Stainless-steel] [Steel] bolts, washers, and nuts.
 - e. Coupling shall be capable of joining PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
 - f. Steel body couplings installed underground on plastic pipe shall be factory equipped with anode.
- B. Corrugated, Stainless-Steel Tubing: Comply with ANSI/IAS LC 1.
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. OmegaFlex, Inc.
 - b. Parker Hannifin Corporation.
 - c. Tru-Flex Metal Hose Corp.
 - 2. Tubing: ASTM A 240/A 240M, corrugated, Series 300 stainless steel.
 - 3. Coating: PE with flame retardant.
 - a. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1) Flame-Spread Index: 25] or less.
 - 2) Smoke-Developed Index: 50] or less.
 - 4. Fittings: Copper-alloy mechanical fittings with ends made to fit and listed for use with corrugated stainless-steel tubing and capable of metal-to-metal seal without gaskets. Include brazing socket or threaded ends complying with ASME B1.20.1.

5. Striker Plates: Steel, designed to protect tubing from penetrations.
 6. Manifolds: Malleable iron or steel with factory-applied protective coating. Threaded connections shall comply with ASME B1.20.1 for pipe inlet and corrugated tubing outlets.
 7. Operating-Pressure Rating: 5 psig.
- C. Aluminum Tubing: Comply with ASTM B 210 and ASTM B 241/B 241M.
1. Aluminum Alloy: Alloy 5456 is prohibited.
 2. Protective Coating: Factory-applied coating capable of resisting corrosion on tubing in contact with masonry, plaster, insulation, water, detergents, and sewerage.
 3. Flare Fittings: Comply with ASME B16.26 and SAE J513.
 - a. Copper-alloy fittings.
 - b. Metal-to-metal compression seal without gasket.
 - c. Dryseal threads shall comply with ASME B1.20.3.
- D. Drawn-Temper Copper Tube: Comply with ASTM B 88, Type K].
1. Copper Fittings: ASME B16.22, wrought copper, and streamlined pattern.
 2. Bronze Flanges and Flanged Fittings: ASME B16.24, Class 150.
 - a. Gasket Material: ASME B16.20, metallic, flat, asbestos free, aluminum o-rings, and spiral-wound metal gaskets.
 - b. Bolts and Nuts: ASME B18.2.1, carbon steel or stainless steel.
 3. Protective Coating for Underground Tubing: Factory-applied, extruded PE a minimum of 0.022 inch thick.
- E. Annealed-Temper Copper Tube: Comply with ASTM B 88, Type K].
1. Copper Fittings: ASME B16.22, wrought copper, and streamlined pattern.
 2. Flare Fittings: Comply with ASME B16.26 and SAE J513.
 - a. Copper fittings with long nuts.
 - b. Metal-to-metal compression seal without gasket.
 - c. Dryseal threads complying with ASME B1.20.3.
 3. Protective Coating for Underground Tubing: Factory-applied, extruded PE a minimum of 0.022 inch thick.
- F. Tin-Lined Copper Tube: ASTM B 280, seamless, annealed, with interior tin-plated lining.
1. Flare Fittings: Comply with ASME B16.26 and SAE J513.
 - a. Copper fittings with long nuts.
 - b. Metal-to-metal compression seal without gasket.
 - c. Dryseal threads complying with ASME B1.20.3.
- G. PE Pipe: ASTM D 2513, SDR 11.

1. PE Fittings: ASTM D 2683, socket-fusion type or ASTM D 3261, butt-fusion type with dimensions matching PE pipe.
2. PE Transition Fittings: Factory-fabricated fittings with PE pipe complying with ASTM D 2513, SDR 11; and steel pipe complying with ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
3. Anodeless Service-Line Risers: Factory fabricated and leak tested.
 - a. Underground Portion: PE pipe complying with ASTM D 2513, SDR 11 inlet.
 - b. Casing: Steel pipe complying with ASTM A 53/A 53M, Schedule 40, black steel, Type E or S, Grade B with corrosion-protective coating covering
 - c. Aboveground Portion: PE transition fitting.
 - d. Outlet shall be threaded or flanged or suitable for welded connection.
 - e. Tracer wire connection.
 - f. Ultraviolet shield.
 - g. Stake supports with factory finish to match steel pipe casing or carrier pipe.
4. Transition Service-Line Risers: Factory fabricated and leak tested.
 - a. Underground Portion: PE pipe complying with ASTM D 2513, SDR 11 inlet connected to steel pipe complying with ASTM A 53/A 53M, Schedule 40, Type E or S, Grade B, with corrosion-protective coating for aboveground outlet.
 - b. Outlet shall be threaded or flanged or suitable for welded connection.
 - c. Bridging sleeve over mechanical coupling.
 - d. Factory-connected anode.
 - e. Tracer wire connection.
 - f. Ultraviolet shield.
 - g. Stake supports with factory finish to match steel pipe casing or carrier pipe.
5. Plastic Mechanical Couplings, NPS 1-1/2 and Smaller: Capable of joining PE pipe to PE pipe.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Mueller Co.
 - 2) Perfection Corporation.
 - b. PE body with molded-in, stainless-steel support ring.
 - c. Buna-nitrile seals.
 - d. Acetal collets.
 - e. Electro-zinc-plated steel stiffener.
6. Plastic Mechanical Couplings, NPS 2 and Larger: Capable of joining PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Mueller Co.
 - 2) Perfection Corporation.

- b. Fiber-reinforced plastic body.
- c. PE body tube.
- d. Buna-nitrile seals.
- e. Acetal collets.
- f. Stainless-steel bolts, nuts, and washers.

2.2 PIPING SPECIALTIES

A. Flexible Piping Joints:

- 1. Approved for LPG service.
- 2. Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
- 3. Minimum working pressure of 250 psig and 250 deg F operating temperature.
- 4. Flanged- or threaded-end connections to match equipment connected and shall be capable of minimum 3/4-inch misalignment.
- 5. Maximum 36-inch length for liquid LPG lines.

B. Appliance Flexible Connectors:

- 1. Indoor, Fixed-Appliance Flexible Connectors: Comply with ANSI Z21.24.
- 2. Indoor, Movable-Appliance Flexible Connectors: Comply with ANSI Z21.69.
- 3. Outdoor, Appliance Flexible Connectors: Comply with ANSI Z21.75.
- 4. Corrugated stainless-steel tubing with polymer coating.
- 5. Operating-Pressure Rating: 0.5 psig.
- 6. End Fittings: Zinc-coated steel.
- 7. Threaded Ends: Comply with ASME B1.20.1.
- 8. Maximum Length: 72 inches

C. Quick-Disconnect Devices: Comply with ANSI Z21.41.

- 1. Copper-alloy convenience outlet and matching plug connector.
- 2. Nitrile seals.
- 3. Hand operated with automatic shutoff when disconnected.
- 4. For indoor or outdoor applications.
- 5. Adjustable, retractable restraining cable.

D. Y-Pattern Strainers:

- 1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
- 2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
- 3. Strainer Screen: 40 mesh startup strainer and perforated stainless-steel basket with 50 percent free area.
- 4. CWP Rating: 125 psig.

E. Basket Strainers:

- 1. Body: ASTM A 126, Class B, high-tensile cast iron with bolted cover and bottom drain connection.

2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
3. Strainer Screen: 60-mesh startup strainer and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig.

F. T-Pattern Strainers:

1. Body: Ductile or malleable iron with removable access coupling and end cap for strainer maintenance.
2. End Connections: Grooved ends.
3. Strainer Screen: [40] [mesh startup strainer and perforated stainless-steel basket with 57 percent free area.
4. CWP Rating: 750 psig.

G. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

2.3 JOINING MATERIALS

- A. Joint Compound and Tape: Suitable for LPG.
- B. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- C. Brazing Filler Metals: Alloy with melting point greater than 1000 deg F complying with AWS A5.8/A5.8M.

2.4 MANUAL GAS SHUTOFF VALVES

- A. See "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles for where each valve type is applied in various services.
- B. Metallic Valves, NPS 2 and Smaller for Liquid Service: Comply with ASME B16.33 and UL 842.
 1. CWP Rating: 150 psig
 2. Threaded Ends: Comply with ASME B1.20.1.
 3. Socket ends for brazed joints.
 4. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 5. Listing by CSA or agency acceptable to authorities having jurisdiction for valves 1 inch and smaller.
 6. Valves 1-1/4 inch and larger shall be suitable for LPG service, with "WOG" indicated on valve body.

- C. General Requirements for Metallic Valves, NPS 2 and Smaller for Vapor Service: Comply with ASME B16.33.
1. CWP Rating: 150 psig
 2. Threaded Ends: Comply with ASME B1.20.1.
 3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
 4. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 5. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.
 6. Service Mark: Valves 1-1/4 inch to NPS 2 shall have initials "WOG" permanently marked on valve body.
- D. General Requirements for Metallic Valves, NPS 2-1/2 and Larger: Comply with ASME B16.38.
1. CWP Rating: 150 psig
 2. Flanged Ends: Comply with ASME B16.5 for steel flanges.
 3. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 4. Service Mark: Initials "WOG" shall be permanently marked on valve body.
- E. One-Piece, Bronze Ball Valve with Bronze Trim: MSS SP-110.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. A.Y. McDonald Mfg. Co.
 - b. Apollo Valves; Conbraco Industries, Inc.
 2. Body: Bronze, complying with ASTM B 584.
 3. Ball: Chrome-plated brass.
 4. Stem: Bronze; blowout proof.
 5. Seats: Reinforced TFE; blowout proof.
 6. Packing: Separate packnut with adjustable-stem packing threaded ends.
 7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 8. CWP Rating: 600 psig.
 9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
 10. Service: Suitable for LPG service with "WOG" indicated on valve body.
- F. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. A.Y. McDonald Mfg. Co.
 - b. Apollo Valves; Conbraco Industries, Inc.

2. Body: Bronze, complying with ASTM B 584.
3. Ball: Chrome-plated bronze.
4. Stem: Bronze; blowout proof.
5. Seats: Reinforced TFE; blowout proof.
6. Packing: Threaded-body packnut design with adjustable-stem packing.
7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
8. CWP Rating: 600 psig.
9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for LPG service with "WOG" indicated on valve body.

G. Two-Piece, Regular-Port Bronze Ball Valves with Bronze Trim: MSS SP-110.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. A.Y. McDonald Mfg. Co.
 - b. Apollo Valves; Conbraco Industries, Inc.
2. Body: Bronze, complying with ASTM B 584.
3. Ball: Chrome-plated bronze
4. Stem: Bronze; blowout proof.
5. Seats: Reinforced TFE.
6. Packing: Threaded-body packnut design with adjustable-stem packing.
7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
8. CWP Rating: 600 psig.
9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for LPG service with "WOG" indicated on valve body.

H. Valve Boxes:

1. Cast-iron, two-section box.
2. Top section with cover with "GAS" lettering.
3. Bottom section with base to fit over valve and barrel a minimum of 5 inches in diameter.
4. Adjustable cast-iron extensions of length required for depth of bury.
5. Include tee-handle, steel operating wrench with socket end fitting valve nut or flat head and with stem of length required to operate valve.

2.5 EARTHQUAKE VALVES

A. Earthquake Valves: Comply with ASCE 25.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Vanguard Valves, Inc.

2. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction.
3. Maximum Operating Pressure: 5 psig.
4. Cast-aluminum body with nickel-plated chrome steel internal parts.
5. Nitrile-rubber valve washer.
6. Sight windows for visual indication of valve position.
7. Threaded-end connections complying with ASME B1.20.1.

B. Earthquake Valves: Comply with ASCE 25.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Pacific Seismic Products, Inc.
2. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction.
3. Maximum Operating Pressure: 0.5 psig
4. Cast-aluminum body with stainless-steel internal parts.
5. Nitrile-rubber, reset-stem o-ring seal.
6. Valve position, open or closed, indicator.
7. Composition valve seat with clapper held by spring or magnet locking mechanism.
8. Level indicator.
9. End Connections: Threaded for valves NPS 2 and smaller; flanged for valves NPS 2-1/2 and larger.

2.6 PRESSURE REGULATORS

A. General Requirements:

1. Single stage and suitable for LPG.
2. Steel jacket and corrosion-resistant components.
3. Elevation compensator.

B. Service Pressure Regulators: Comply with ANSI Z21.80.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Meter Company.
 - b. Fisher Control Valves & Instruments; a brand of Emerson Process Management.
2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.
5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
6. Orifice: Aluminum; interchangeable.
7. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet and no pressure sensing piping external to the regulator.

9. Pressure regulator shall maintain discharge pressure setting downstream and not exceed 150 percent of design discharge pressure at shutoff.
10. Overpressure Protection Device: Factory mounted on pressure regulator.
11. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.

C. Line Pressure Regulators: Comply with ANSI Z21.80.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Meter Company.
 - b. Fisher Control Valves & Instruments; a brand of Emerson Process Management.
2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.
5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
6. Orifice: Aluminum; interchangeable.
7. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet and no pressure sensing piping external to the regulator.
9. Pressure regulator shall maintain discharge pressure setting downstream and not exceed 150 percent of design discharge pressure at shutoff.
10. Overpressure Protection Device: Factory mounted on pressure regulator.
11. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.

D. Appliance Pressure Regulators: Comply with ANSI Z21.18.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Eaton.
 - b. Maxitrol Company.
2. Body and Diaphragm Case: Die-cast aluminum.
3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.
5. Seat Disc: Nitrile rubber.
6. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
7. Factory-Applied Finish: Minimum three-layer polyester and polyurethane paint finish.
8. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.

2.7 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. A.Y. McDonald Mfg. Co.
 - b. HART Industrial Unions, LLC.
 - c. Watts; a Watts Water Technologies company.
2. Description:
 - a. Standard: ASSE 1079.
 - b. Pressure Rating: 150 psig
 - c. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Matco-Norca.
 - b. Watts; a Watts Water Technologies company.
2. Description:
 - a. Standard: ASSE 1079.
 - b. Factory-fabricated, bolted, companion-flange assembly.
 - c. Pressure Rating: 150 psig].
 - d. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
2. Description:
 - a. Nonconducting materials for field assembly of companion flanges.
 - b. Pressure Rating: 150 psig
 - c. Gasket: Neoprene or phenolic.
 - d. Bolt Sleeves: Phenolic or polyethylene.
 - e. Washers: Phenolic with steel backing washers.

2.8 LABELING AND IDENTIFYING

- A. Detectable Warning Tape: Acid- and alkali-resistant PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick,

continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored yellow.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for LPG piping system to verify actual locations of piping connections before equipment installation.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EARTHWORK

- A. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

3.3 PREPARATION

- A. Close equipment shutoff valves before turning off LPG to premises or piping section.
- B. Inspect LPG piping according to NFPA 58 and NFPA 54 the International Fuel Gas Code to determine that LPG utilization devices are turned off in piping section affected.
- C. Comply with NFPA 58 and NFPA 54 the International Fuel Gas Code requirements for prevention of accidental ignition.

3.4 OUTDOOR PIPING INSTALLATION

- A. Comply with NFPA 58 and NFPA 54 the International Fuel Gas Code requirements for installation and purging of LPG piping.
- B. Install underground, LPG piping buried at least 36 inches below finished grade. Comply with requirements in Section Earth Moving" for excavating, trenching, and backfilling.
 - 1. If LPG piping is installed less than 36 inches below finished grade, install it in containment conduit.
- C. Install underground, PE, LPG piping according to ASTM D 2774.
- D. Copper Tubing with Protective Coating:
 - 1. Apply joint cover kits over tubing to cover, seal, and protect joints.
 - 2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.

- E. Install fittings for changes in direction and branch connections.
- F. Joints for connection to inlets and outlets on vaporizers, air mixers, regulators, and valves may be flanged or threaded to match the equipment.

3.5 INDOOR PIPING INSTALLATION

- A. Comply with NFPA 54 the International Fuel Gas Code for installation and purging of LPG piping.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.
- D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- G. Locate valves for easy access.
- H. Install LPG piping at uniform grade of 2 percent down toward drip and sediment traps.
- I. Install piping free of sags and bends.
- J. Install fittings for changes in direction and branch connections.
- K. Verify final equipment locations for roughing-in.
- L. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.
- M. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where readily accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.
 - 1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.
- N. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.

- O. Conceal pipe installations in walls, pipe spaces, utility spaces, and above ceilings.
 - 1. Above Accessible Ceilings: LPG piping, fittings, valves, and regulators may be installed in accessible spaces without containment conduit.
 - 2. In Walls or Partitions: Protect tubing installed inside partitions or hollow walls from physical damage using steel striker barriers at rigid supports.
 - a. Exception: Tubing passing through partitions or walls does not require striker barriers.
 - 3. Prohibited Locations:
 - a. Do not install LPG piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
 - b. Do not install LPG piping in solid walls or partitions.
 - c. Do not install piping below floor slab.
- P. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
- Q. Connect branch piping from top or side of horizontal piping.
- R. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.
- S. Do not use LPG piping as grounding electrode.
- T. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.
- U. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."
- V. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."
- W. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

3.6 SERVICE-METER ASSEMBLY INSTALLATION

- A. Install service-meter assemblies above ground
- B. Install metal shutoff valves upstream from service regulators. Shutoff valves are not required at second regulators if two regulators are installed in series.
- C. Install strainer on inlet of service-pressure regulator and meter set.

- D. Install service regulators mounted outside with vent outlet horizontal or facing down. Install screen in vent outlet if not integral with service regulator.
- E. Install metal shutoff valves upstream from service meters. Install dielectric fittings downstream from service meters.
- F. Install service meters downstream from pressure regulators.
- G. Install metal bollards to protect meter assemblies. Comply with requirements in Section 055000 "Metal Fabrications" for pipe bollards.

3.7 VALVE INSTALLATION

- A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing, aluminum, or copper connector.
- B. Install underground valves with valve boxes.
- C. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.
- D. Install earthquake valves aboveground outside buildings according to listing.
- E. Install anode for metallic valves in underground PE piping.

3.8 PIPING JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Threaded Joints:
 1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
 2. Cut threads full and clean using sharp dies.
 3. Ream threaded pipe ends to remove burrs and restore full ID of pipe.
 4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
 5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- D. Welded Joints:
 1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
 2. Bevel plain ends of steel pipe.
 3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Ch. 22, "Pipe and Tube."
- F. Flanged Joints: Install gasket material, size, type, and thickness appropriate for LPG service. Install gasket concentrically positioned.
- G. Flared Joints: Cut tubing with roll cutting tool. Flare tube end with tool to result in flare dimensions complying with SAE J513. Tighten finger tight, then use wrench. Do not overtighten.
- H. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
 - 1. Plain-End Pipe and Fittings: Use butt fusion.
 - 2. Plain-End Pipe and Socket Fittings: Use socket fusion.

3.9 HANGER AND SUPPORT INSTALLATION

- A. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:
 - 1. NPS 1 and Smaller: Maximum span, 96 inches; minimum rod size, 3/8 inch.
 - 2. NPS 1-1/4: Maximum span, 108 inches; minimum rod size, 3/8 inch.
 - 3. NPS 1-1/2 and NPS 2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
- B. Install hangers for horizontal, drawn-temper copper tubing with the following maximum spacing and minimum rod sizes:
 - 1. NPS 3/8: Maximum span, 48 inches; minimum rod size, 3/8 inch.
 - 2. NPS 1/2 and NPS 5/8: Maximum span, 72 inches; minimum rod size, 3/8 inch.
 - 3. NPS 3/4 and NPS 7/8: Maximum span, 84 inches; minimum rod size, 3/8 inch.
 - 4. NPS 1: Maximum span, 96 inches; minimum rod size, 3/8 inch.

3.10 CONNECTIONS

- A. Connect to utility's gas main according to utility's procedures and requirements.
- B. Install LPG piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.
- C. Install piping adjacent to appliances to allow service and maintenance of appliances.
- D. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliances and equipment. Install union between valve and appliances or equipment.
- E. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.11 LABELING AND IDENTIFYING

- A. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for piping and valve identification.
- B. Install detectable warning tape directly above gas piping, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.12 PAINTING

- A. Comply with requirements in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting" for painting interior and exterior LPG piping.
- B. Paint exposed, exterior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components with factory-applied paint or protective coating.
 - 1. Alkyd System: MPI EXT 5.1D.
 - a. Prime Coat: Alkyd anticorrosive metal primer.
 - b. Intermediate Coat: Exterior alkyd enamel matching topcoat.
 - c. Topcoat: Exterior alkyd enamel
 - d. Color: Gray.
- C. Paint exposed, interior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components with factory-applied paint or protective coating.
 - 1. Latex Over Alkyd Primer System: MPI INT 5.1Q.
 - a. Prime Coat: Alkyd anticorrosive] metal primer.
 - b. Intermediate Coat: Interior latex matching topcoat.
 - c. Topcoat: Interior latex flat
 - d. Color: Gray.
- D. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

3.13 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Test, inspect, and purge LPG according to NFPA 58 and NFPA 54 and requirements of authorities having jurisdiction.
- C. LPG piping will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.14 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain LPG equipment.

3.15 OUTDOOR PIPING SCHEDULE

- A. Underground LPG liquid piping shall be one of the following:
 - 1. Schedule 40 steel pipe with wrought-steel fittings and welded joints, or mechanical couplings. Coat pipe and fittings with protective coating for steel piping.
 - 2. Annealed]-temper copper tube, Type K with wrought-copper fittings and brazed joints. Coat pipe and fittings with protective coating for copper tubing.
- B. Aboveground LPG liquid piping shall be the following:
 - 1. NPS 2and Smaller: Schedule 40 steel pipe, malleable-iron threaded fittings and threaded joints. Coat pipe and fittings with protective coating for steel piping.
 - 2. Annealed]-temper copper tube, Type L with wrought-copper fittings and brazed joints. Coat pipe and fittings with protective coating for copper tubing.
- C. Underground LPG vapor piping shall be one of the following: Piping shall not be installed below building slab
 - 1. PE pipe and fittings joined by heat-fusion, or mechanical couplings; service-line risers with tracer wire terminated in an accessible location.
 - 2. Schedule 40, steel pipe with wrought-steel fittings and welded joints, or mechanical couplings. Coat pipe and fittings with protective coating for steel piping.
 - 3. Annealed]-temper copper tube, Type L with wrought-copper fittings and brazed joints. Coat pipe and fittings with protective coating for copper tubing.
- D. Aboveground LPG vapor pipingshall be one of] the following:
 - 1. Schedule 40, steel pipe with malleable-iron fittings and threaded joints.
 - 2. Schedule 40, steel pipe with wrought-steel fittings and welded joints, or mechanical couplings.
 - 3. Annealed]-temper copper tube, Type L with wrought-copper fittings and brazed joints. Coat pipe and fittings with protective coating for copper tubing.
- E. Containment Conduit: Schedule 40, steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.

3.16 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES LESS THAN 0.5 PSIG

- A. Aboveground, branch piping NPS 1 and smaller shall be one of the following:
 - 1. Corrugated stainless-steel tubing with mechanical fittings having socket or threaded ends to match adjacent piping.
 - 2. Annealed-temper, tin-lined copper tube with flared joints and fittings.
 - 3. Annealed-temper copper tube with wrought-copper fittings and brazed] joints.

4. Aluminum tube with flared fittings and joints.
5. Schedule 40, steel pipe with malleable-iron fittings and threaded joints.

B. Aboveground, distribution piping shall be one of] the following:

1. Schedule 40, steel pipe with malleable-iron fittings and threaded joints.
2. Schedule 40, steel pipe with wrought-steel fittings and welded joints.
3. Drawn-temper copper tube, Type L with wrought-copper fittings and brazed joints.

C. Underground, below building, piping shall not be allowed

3.17 UNDERGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Connections to Existing Gas Piping: Use valve and fitting assemblies made for tapping utility's gas mains and listed by an NRTL.

B. Underground Vapor Piping:

1. PE valves.
2. NPS 2 and Smaller: Bronze, lubricated] plug valves.

3.18 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Aboveground Liquid Piping:

1. Two-piece, full]-port, bronze ball valves with bronze trim.

B. Valves for pipe NPS 2 and smaller at service meter shall be one of the following:

1. One-piece, bronze ball valve with bronze trim.
2. Two-piece, full]-port, bronze ball valves with bronze trim.
3. Bronze plug valve.

C. Valves for pipe NPS 2-1/2 and larger at service meter shall be[one of] the following:

1. Two-piece, full]-port, bronze ball valves with bronze trim.
2. Bronze plug valve.
3. Cast-iron, nonlubricated plug valve.

D. Distribution piping valves for pipe NPS 2 and smaller shall be one of the following:

1. One-piece, bronze ball valve with bronze trim.
2. Two-piece, full]-port, bronze ball valves with bronze trim.
3. Bronze plug valve.

END OF SECTION 231126

SECTION 232113 - CONDENSATE DRAIN PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.

1.2 SUMMARY

- A. Section includes pipe and fitting materials and joining methods for the following:
 - 1. Condensate-drain piping.

1.3 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Installers of Pressure-Sealed Joints: Installers shall be certified by pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.
- B. Steel Support Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Deliver pipes and tubes with factory applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and prevent entrance of dirt, debris, and moisture.
- B. Store piping in a clean and protected area with end caps in place to ensure that piping interior and exterior are clean when installed. Stored piping shall be elevated above grade. Stored piping shall not exceed structural capacity of the floor.
- C. Protect flanges, fittings, and piping specialties from dirt, debris, and moisture.
- D. Protect stored plastic piping from direct sunlight. Support to prevent sagging and bending.

1.5 COORDINATION

- A. Coordinate layout and installation of piping with equipment and with other installations.
- B. Coordinate pipe sleeve installation for foundation wall penetrations.

- C. Coordinate installation of roof curbs, equipment supports, and roof penetrations.
- D. Coordinate pipe fitting pressure classes with products specified in related Sections.
- E. Coordinate installation of pipe sleeves for penetrations in exterior walls and floor assemblies.
- F. Coordinate with requirements for firestopping for fire and smoke wall and floor assemblies.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Condensate drain piping components and installation shall be capable of withstanding the following minimum working pressure and temperature unless otherwise indicated:
 - 1. Condensate-Drain Piping: 150 deg F.

2.2 COPPER TUBE AND FITTINGS

- A. Drawn-Temper Copper Tubing: ASTM B 88, Type L .
- B. Copper or Bronze Pressure-Seal Fittings:
 - 1. Housing: Copper.
 - 2. O-Rings and Pipe Stops: EPDM.
 - 3. Tools: Manufacturer's special tools.
 - 4. Minimum 200-psig working-pressure rating at 250 deg F.
- C. Wrought-Copper Unions: ASME B16.22.

2.3 JOINING MATERIALS

- A. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.
- B. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.

2.4 TRANSITION FITTINGS

- A. Plastic-to-Metal Transition Fittings:
 - 1. One-piece fitting with one threaded brass or copper insert and one solvent-cement-joint end of material and wall thickness to match plastic pipe material.
- B. Plastic-to-Metal Transition Unions:

1. Brass or copper end, solvent-cement-joint end of material and wall thickness to match plastic pipe material, rubber gasket, and threaded union.

2.5 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
- B. Dielectric Unions:
 1. Description:
 - a. Standard: ASSE 1079.
 - b. Pressure Rating: 125 psig minimum at 180 deg F.
 - c. End Connections: Solder-joint copper alloy and threaded ferrous.
- C. Dielectric Flanges:
 1. Description:
 - a. Standard: ASSE 1079.
 - b. Factory-fabricated, bolted, companion-flange assembly.
 - c. Pressure Rating: 125 psig minimum at 180 deg F.
 - d. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
- D. Dielectric-Flange Insulating Kits:
 1. Description:
 - a. Nonconducting materials for field assembly of companion flanges.
 - b. Pressure Rating: 150 psig.
 - c. Gasket: Neoprene or phenolic.
 - d. Bolt Sleeves: Phenolic or polyethylene.
 - e. Washers: Phenolic with steel backing washers.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

- A. Interior and exterior Condensate-Drain Piping: Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

3.2 PIPING INSTALLATIONS

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Install piping as indicated unless deviations are approved by the engineer..

- B. Install piping tight to slabs, beams, joists, columns, walls, and other building elements unless noted otherwise.
- C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to permit valve servicing.
- G. Install piping at indicated slopes.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation plus 1-inch clearance around insulation.
- K. Select system components with pressure rating equal to or greater than system operating pressure.
- L. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
- M. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
- N. Reduce pipe sizes using eccentric reducer fitting installed with level side up.
- O. Install branch connections to mains using mechanically formed tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.
- P. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.
- Q. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.
- R. Install shutoff valve immediately upstream of each dielectric fitting.
- S. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section "Sleeves and Sleeve Seals for HVAC Piping."
- T. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section "Sleeves and Sleeve Seals for HVAC Piping."

- U. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section "Escutcheons for HVAC Piping."

3.3 DIELECTRIC FITTING INSTALLATION

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric unions.
- C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges or flange kits.

3.4 HANGERS AND SUPPORTS

- A. Comply with requirements in Section "Hangers and Supports for HVAC Piping and Equipment" for hanger, support, and anchor devices. Comply with the following requirements for maximum spacing of supports.
- B. Comply with requirements in Section "Vibration and Seismic Controls for HVAC" for seismic restraints.
- C. Install the following pipe attachments:
 - 1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
 - 2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer.
 - 3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
 - 4. Spring hangers to support vertical runs.
 - 5. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
 - 6. On plastic pipe, install pads or cushions on bearing surfaces to prevent hanger from scratching pipe.
- D. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:
 - 1. NPS 3/4: Maximum span, 5 feet; minimum rod size, 1/4 inch.
 - 2. NPS 1: Maximum span, 6 feet; minimum rod size, 1/4 inch.
 - 3. NPS 1-1/4: Maximum span, 7 feet; minimum rod size, 3/8 inch.
 - 4. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
 - 5. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
 - 6. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
 - 7. NPS 3 and Larger: Maximum span, 10 feet; minimum rod size, 3/8 inch.
- E. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

3.5 PIPE JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- D. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8/A5.8M.
- E. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- F. Mechanically Formed, Copper-Tube-Outlet Joints: Use manufacturer-recommended tool and procedure, and brazed joints.
- G. Pressure-Sealed Joints: Use manufacturer-recommended tool and procedure. Leave insertion marks on pipe after assembly.

3.6 TERMINAL EQUIPMENT CONNECTIONS

- A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.

3.7 CLEANING

- A. Before installation of copper tubing, clean tubing and fittings with trichloroethylene.

END OF SECTION 232113

SECTION 232300 - REFRIGERANT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.

1.2 SUMMARY

- A. This Section includes refrigerant piping used for air-conditioning applications.

1.3 PERFORMANCE REQUIREMENTS

- A. Line Test Pressure for Refrigerant R-410A:
 - 1. Suction Lines for Air-Conditioning Applications: 300 psig.
 - 2. Suction Lines for Heat-Pump Applications: 535 psig.
 - 3. Hot-Gas and Liquid Lines: 535 psig.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of valve and refrigerant piping specialty indicated. Include pressure drop, based on manufacturer's test data, for the following:
 - 1. Thermostatic expansion valves.
 - 2. Solenoid valves.
 - 3. Hot-gas bypass valves.
 - 4. Filter dryers.
 - 5. Strainers.
 - 6. Pressure-regulating valves.
- B. Shop Drawings: Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes, flow capacities, valve arrangements and locations, slopes of horizontal runs, oil traps, double risers, wall and floor penetrations, and equipment connection details. Show interface and spatial relationships between piping and equipment.
 - 1. Refrigerant piping indicated on Drawings is schematic only. Size piping and design actual piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.

1.5 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

1.7 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
- B. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."
- C. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

1.8 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Deliver pipes and tubes with factory applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and prevent entrance of dirt, debris, and moisture.
- B. Store piping in a clean and protected area with end caps in place to ensure that piping interior and exterior are clean when installed. Stored piping shall be elevated above grade. Stored piping shall not exceed structural capacity of the floor.
- C. Protect flanges, fittings, and piping specialties from dirt, debris, and moisture.

1.9 COORDINATION

- A. Coordinate size and location of roof curbs, equipment supports, and roof penetrations.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

- A. Copper Tube: ASTM B 280, Type ACR.
- B. Wrought-Copper Fittings: ASME B16.22.
- C. Wrought-Copper Unions: ASME B16.22.
- D. Solder Filler Metals: ASTM B 32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.

- E. Brazing Filler Metals: AWS A5.8.
- F. Flexible Connectors:
 - 1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
 - 2. End Connections: Socket ends.
 - 3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch- long assembly.
 - 4. Pressure Rating: Factory test at minimum 500 psig.
 - 5. Maximum Operating Temperature: 250 deg F.

2.2 VALVES AND SPECIALTIES

- A. Diaphragm Packless Valves:
 - 1. Body and Bonnet: Forged brass or cast bronze; globe design with straight-through or angle pattern.
 - 2. Diaphragm: Phosphor bronze and stainless steel with stainless-steel spring.
 - 3. Operator: Rising stem and hand wheel.
 - 4. Seat: Nylon.
 - 5. End Connections: Socket, union, or flanged.
 - 6. Working Pressure Rating: 500 psig.
 - 7. Maximum Operating Temperature: 275 deg F.
- B. Check Valves:
 - 1. Body: Ductile iron, forged brass, or cast bronze; globe pattern.
 - 2. Bonnet: Bolted ductile iron, forged brass, or cast bronze; or brass hex plug.
 - 3. Piston: Removable polytetrafluoroethylene seat.
 - 4. Closing Spring: Stainless steel. Manual Opening Stem: Seal cap, plated-steel stem, and graphite seal.
 - 5. End Connections: Socket, union, threaded, or flanged.
 - 6. Maximum Opening Pressure: 0.50 psig.
 - 7. Working Pressure Rating: 500 psig.
 - 8. Maximum Operating Temperature: 275 deg F.
- C. Service Valves:
 - 1. Body: Forged brass with brass cap including key end to remove core.
 - 2. Core: Removable ball-type check valve with stainless-steel spring.
 - 3. Seat: Polytetrafluoroethylene.
 - 4. End Connections: Copper spring.
 - 5. Working Pressure Rating: 500 psig.
- D. Solenoid Valves: Comply with ARI 760 and UL 429; listed and labeled by an NRTL.
 - 1. Body and Bonnet: Plated steel.
 - 2. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
 - 3. Seat: Polytetrafluoroethylene.

4. End Connections: Threaded.
 5. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter, and [24] [115] [208]-V ac coil.
 6. Working Pressure Rating: 400 psig.
 7. Maximum Operating Temperature: 240 deg F.
 8. Manual operator.
- E. Safety Relief Valves: Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
1. Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.
 2. Piston, Closing Spring, and Seat Insert: Stainless steel.
 3. Seat Disc: Polytetrafluoroethylene.
 4. End Connections: Threaded.
 5. Working Pressure Rating: 400 psig.
 6. Maximum Operating Temperature: 240 deg F.
- F. Straight-Type Strainers:
1. Body: Welded steel with corrosion-resistant coating.
 2. Screen: 100-mesh stainless steel.
 3. End Connections: Socket or flare.
 4. Working Pressure Rating: 500 psig.
 5. Maximum Operating Temperature: 275 deg F.
- G. Angle-Type Strainers:
1. Body: Forged brass or cast bronze.
 2. Drain Plug: Brass hex plug.
 3. Screen: 100-mesh monel.
 4. End Connections: Socket or flare.
 5. Working Pressure Rating: 500 psig.
 6. Maximum Operating Temperature: 275 deg F.
- H. Moisture/Liquid Indicators:
1. Body: Forged brass.
 2. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
 3. Indicator: Color coded to show moisture content in ppm.
 4. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.
 5. End Connections: Socket or flare.
 6. Working Pressure Rating: 500 psig.
 7. Maximum Operating Temperature: 240 deg F.
- I. Permanent Filter Dryers: Comply with ARI 730.
1. Body and Cover: Painted-steel shell.
 2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
 3. Desiccant Media.
 4. Designed for reverse flow (for heat-pump applications).

5. End Connections: Socket.
6. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
7. Working Pressure Rating: 500 psig.
8. Maximum Operating Temperature: 240 deg F.

J. Receivers: Comply with ARI 495.

1. Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
2. Comply with UL 207; listed and labeled by an NRTL.
3. Body: Welded steel with corrosion-resistant coating.
4. Tappings: Inlet, outlet, liquid level indicator, and safety relief valve.
5. End Connections: Socket or threaded.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 275 deg F.

K. Liquid Accumulators: Comply with ARI 495.

1. Body: Welded steel with corrosion-resistant coating.
2. End Connections: Socket or threaded.
3. Working Pressure Rating: 500 psig.
4. Maximum Operating Temperature: 275 deg F.

2.3 REFRIGERANTS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Atofina Chemicals, Inc.
 2. DuPont Company; Fluorochemicals Div.
 3. Honeywell, Inc.; Genetron Refrigerants.
 4. INEOS Fluor Americas LLC.
- C. ASHRAE 34, R-410A: Pentafluoroethane/Difluoromethane.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS FOR REFRIGERANT R-410A

- A. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications: Copper, Type ACR, annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.
- B. Hot-Gas and Liquid Lines: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with brazed joints.

3.2 VALVE AND SPECIALTY APPLICATIONS

- A. Install diaphragm packless valves in suction and discharge lines of compressor.
- B. Install service valves for gage taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.
- C. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.
- D. Except as otherwise indicated, install diaphragm packless valves on inlet and outlet side of filter dryers.
- E. Install a full-sized, three-valve bypass around filter dryers.
- F. Install solenoid valves upstream from each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at top.
- G. Install thermostatic expansion valves as close as possible to distributors on evaporators.
 - 1. Install valve so diaphragm case is warmer than bulb.
 - 2. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.
 - 3. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.
- H. Install safety relief valves where required by ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside according to ASHRAE 15.
- I. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.
- J. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for device being protected:
 - 1. Solenoid valves.
 - 2. Thermostatic expansion valves.
 - 3. Hot-gas bypass valves.
 - 4. Compressor.
- K. Install filter dryers in liquid line between compressor and thermostatic expansion valve.
- L. Install receivers sized to accommodate pump-down charge.
- M. Install flexible connectors at compressors.

3.3 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss,

expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved by the engineer.

- B. Verify final equipment locations before roughing in piping.
- C. Install piping tight to slabs, beams, joists, columns, walls, and other building elements unless noted otherwise.
- D. Install refrigerant piping according to ASHRAE 15.
- E. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- F. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- G. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- H. Install piping adjacent to machines to allow service and maintenance.
- I. Install piping free of sags and bends.
- J. Install fittings for changes in direction and branch connections.
- K. Select system components with pressure rating equal to or greater than system operating pressure.
- L. Refer to Section "Instrumentation and Control for HVAC" and Section "Sequence of Operations for HVAC Controls" for solenoid valve controllers, control wiring, and sequence of operation.
- M. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.
- N. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Section "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.
- O. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.
- P. Slope refrigerant piping as follows:
 - 1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
 - 2. Install horizontal suction lines with a uniform slope downward to compressor.
 - 3. Install traps and double risers to entrain oil in vertical runs.
 - 4. Liquid lines may be installed level.

- Q. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.
- R. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.
- S. Identify refrigerant piping and valves according to Section "Identification for HVAC Piping and Equipment."
- T. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section "Sleeves and Sleeve Seals for HVAC Piping."
- U. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section "Sleeves and Sleeve Seals for HVAC Piping."
- V. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section "Escutcheons for HVAC Piping."

3.4 PIPE JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide), during brazing or welding, to prevent scale formation.
- D. Soldered Joints: Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook."
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."
 - 1. Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper pipe.
 - 2. Use Type BAg, cadmium-free silver alloy for joining copper with bronze or steel.
- F. Welded Joints: Construct joints according to AWS D10.12/D10.12M.
- G. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.5 HANGERS AND SUPPORTS

- A. Hanger, support, and anchor products are specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
- B. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet long.
2. Roller hangers and spring hangers for individual horizontal runs 20 feet or longer.
3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
4. Spring hangers to support vertical runs.
5. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

C. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes:

1. NPS 1/2: Maximum span, 60 inches; minimum rod size, 1/4 inch.
2. NPS 5/8: Maximum span, 60 inches; minimum rod size, 1/4 inch.
3. NPS 1: Maximum span, 72 inches; minimum rod size, 1/4 inch.
4. NPS 1-1/4: Maximum span, 96 inches; minimum rod size, 3/8 inch.
5. NPS 1-1/2: Maximum span, 96 inches; minimum rod size, 3/8 inch.
6. NPS 2: Maximum span, 96 inches; minimum rod size, 3/8 inch.
7. NPS 2-1/2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
8. NPS 3: Maximum span, 10 feet; minimum rod size, 3/8 inch.
9. NPS 4: Maximum span, 12 feet; minimum rod size, 1/2 inch.

D. Support multifloor vertical runs at least at each floor.

3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:

1. Comply with ASME B31.5, Chapter VI.
2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in Part 1 "Performance Requirements" Article.
 - a. Fill system with nitrogen to the required test pressure.
 - b. System shall maintain test pressure at the manifold gage throughout duration of test.
 - c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
 - d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

3.7 SYSTEM CHARGING

A. Charge system using the following procedures:

1. Install core in filter dryers after leak test but before evacuation.

2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
4. Charge system with a new filter-dryer core in charging line.

3.8 ADJUSTING

- A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.
- B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.
- C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.
- D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:
 1. Open shutoff valves in condenser water circuit.
 2. Verify that compressor oil level is correct.
 3. Open compressor suction and discharge valves.
 4. Open refrigerant valves except bypass valves that are used for other purposes.
 5. Check open compressor-motor alignment and verify lubrication for motors and bearings.
- E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION 232300

SECTION 233113 - METAL DUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

1. Single-wall rectangular ducts and fittings.
2. Sheet metal materials.
3. Duct liner.
4. Sealants and gaskets.
5. Hangers and supports.

- B. Related Sections:

1. Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
2. Section "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.3 DEFINITIONS

- A. Sealing Requirements Definitions: For the purposes of duct systems sealing requirements specified in this section, the following definitions apply:

- B. Longitudinal Seams: Joints oriented in the direction of airflow.

- C. Transverse joints: Connections of the two duct sections oriented perpendicular to airflow.

- D. Duct wall penetrations: Openings made by any screw, fastener, pipe, rod or wire.

- E. SMACNA Seal Classes are defined as follows:

1. A - All transverse joints, longitudinal seams, and duct wall penetrations.
2. B – All transverse joints and longitudinal seams.
3. C – Transverse joints only.

- F. Conditioned Spaces: a cooled space, heated space, or indirectly conditioned space. An indirectly conditioned space includes return air plenums.

1.4 PERFORMANCE REQUIREMENTS

- A. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of the following products:
 - 1. Liners and adhesives.
 - 2. Sealants and gaskets.

1.6 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.7 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
 - 2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports.
 - 3. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.
- B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."
- C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."
- D. NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilation Systems"

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver sealant and fire-stopping materials to site in original unopened containers or bundles with labels informing about manufacturer, product name and designation, color, expiration period for use, pot life, curing time, and mixing instructions for multi-component materials.
- B. Store and handle sealant materials in compliance with manufacturers' recommendations to prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.
- C. Deliver and store stainless steel sheets with mill-applied adhesive protective paper, maintained through fabrication and installation.

PART 2 - PRODUCTS

2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.2 SINGLE-WALL ROUND DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following :
 - a. Lindab Inc.
 - b. McGill AirFlow LLC.
 - c. SEMCO Incorporated.
 - d. Sheet Metal Connectors, Inc.
 - e. Spiral Manufacturing Co., Inc.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - 1. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.

- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - 1. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
 - 2. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.
- D. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 SHEET METAL MATERIALS

- A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
 - 1. Galvanized Coating Designation: G60 or G90 for use in concealed, interior ductwork, G90 for all exterior and exposed ductwork.
 - 2. Finishes for Surfaces Exposed to View: Mill phosphatized.
- C. Carbon-Steel Sheets: Comply with ASTM A 1008/A 1008M, with oiled, matte finish for exposed ducts.
- D. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304 or 316, as indicated in the "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish shall be No. 2B, No. 2D, No. 3, or No. 4 as indicated in the "Duct Schedule" Article.
- E. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
 - 1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.
- F. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.4 DUCT LINER

- A. Fibrous-Glass Duct Liner: Comply with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following :
 - a. CertainTeed Corporation; Insulation Group.
 - b. Johns Manville.
 - c. Knauf Insulation.
 - d. Owens Corning.
 2. Solvent or Water-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.
 - a. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 3. Surface shall be smooth and coated to prevent erosion of glass fibers into air stream.
 4. Sound Absorption Coefficient NRC shall be no less than 0.70 for 1" thick.
- B. Insulation Pins and Washers:
1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
 2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick galvanized steel, aluminum, or stainless steel; with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
- C. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 7-11, "Flexible Duct Liner Installation."
1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
 2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
 3. Butt transverse joints without gaps, and coat joint with adhesive.
 4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
 5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
 6. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpm.
 7. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.

8. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:
 - a. Fan discharges.
 - b. Intervals of lined duct preceding unlined duct.
 - c. Upstream edges of transverse joints in ducts where air velocities are higher than 2500 fpm or where indicated.
9. Secure insulation between perforated sheet metal inner duct of same thickness as specified for outer shell. Use mechanical fasteners that maintain inner duct at uniform distance from outer shell without compressing insulation.
 - a. Sheet Metal Inner Duct Perforations: 3/32-inch diameter, with an overall open area of 23 percent.
10. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

2.5 SEALANT AND GASKETS

- A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
- B. Water-Based Joint and Seam Sealant:
 1. Application Method: Brush on.
 2. Solids Content: Minimum 65 percent.
 3. Water resistant.
 4. Mold and mildew resistant.
 5. VOC: Maximum 75 g/L (less water).
 6. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
 7. Service: Indoor or outdoor.
 8. Substrate: Compatible with galvanized sheet steel, stainless steel, or aluminum sheets.
- C. Solvent-Based Joint and Seam Sealant:
 1. Application Method: Brush on.
 2. Base: Synthetic rubber resin.
 3. Solvent: Toluene and heptane.
 4. Solids Content: Minimum 60 percent.
 5. Water resistant.
 6. Mold and mildew resistant.
 7. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 8. VOC: Maximum 395 g/L.
 9. Maximum Static-Pressure Class: 10-inch wg, positive or negative.

10. Service: Indoor or outdoor.
11. Substrate: Compatible with galvanized sheet steel, stainless steel, or aluminum sheets.

D. Flanged Joint Sealant: Comply with ASTM C 920.

1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.
6. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

E. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.6 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.

E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.

F. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

H. Trapeze and Riser Supports:

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.
- B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.
- C. Install round ducts in maximum practical lengths.
- D. Install ducts with fewest possible joints.
- E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.
- F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
- G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.
- I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.
- J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.
- K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Section "Air Duct Accessories" for fire and smoke dampers.
- L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

3.2 INSTALLATION OF EXPOSED DUCTWORK

- A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.
- B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

- C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.
- D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.
- E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 DUCT SEALING

- A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article below, and according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- B. Solvent based sealant shall only be used in applications where freezing may occur before sealant is cured. Water based sealant shall be used in all other applications.
- C. Prepare duct surface in accordance with duct sealant manufacturer's printed instructions.
- D. Seal externally insulated ducts prior to installation of insulation.
- E. All duct sealing shall be in accordance with ASHRAE standard 90.1.

3.4 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."
- B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
 - 1. Where practical, install concrete inserts before placing concrete.
 - 2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
 - 3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
 - 4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
- C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.
- D. Hangers Exposed to View: Threaded rod and angle or channel supports.
- E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum interval of 16 feet.

- F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.5 CONNECTIONS

- A. Make connections to equipment with flexible connectors complying with Section "Air Duct Accessories."
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.6 PAINTING

- A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Section "Exterior Painting" and Section "Interior Painting."

3.7 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Inspections and Leakage Tests:
 - 1. All ductwork shall be approved by Architect prior to the application of external insulation. Smoke testing, pressure testing, or other leakage testing will be required if inspection is not performed.

3.8 CLEANING

- A. Vacuum ducts prior to final acceptance to remove construction dust and debris.

3.9 START UP

- A. Air Balance: Comply with requirements in Section "Testing, Adjusting, and Balancing for HVAC."

3.10 DUCT SCHEDULE

- A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:
- B. Supply Ducts:
 - 1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:
 - a. Pressure Class: Positive 2-inch wg.

- b. Minimum SMACNA Seal Class: A for ducts located outdoors, B for ducts located in unconditioned spaces, and C for ducts located in conditioned spaces.
 - c. Round runouts to supply diffusers may be “snap-lock” duct meeting the pressure classification.
 - 2. Ducts Connected to Constant-Volume Air-Handling Units:
 - a. Pressure Class: Positive 4-inch wg.
 - b. Minimum SMACNA Seal Class: A for ducts located outdoors and in unconditioned spaces, B for ducts located in conditioned spaces.
 - c. SMACNA Leakage Class for Rectangular: 6.
 - d. SMACNA Leakage Class for Round and Flat Oval: 6.
- C. Return Ducts:
 - 1. All Return Ducts:
 - a. Pressure Class: negative 2-inch wg.
 - b. Minimum SMACNA Seal Class: A for ducts located outdoors, B for ducts located in unconditioned spaces and C for ducts located in conditioned spaces.
- D. Exhaust Ducts:
 - 1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:
 - a. Pressure Class: Negative 1-inch wg.
 - b. Minimum SMACNA Seal Class: C for ducts located outdoors and in unconditioned spaces, and B for ducts located in conditioned spaces.
 - 2. Ducts Connected to Fans Exhausting Laboratory and Process (ASHRAE 62.1, Class 3 and 4) Air:
 - a. Type 316, stainless-steel sheet.
 - 1) Exposed to View: No. 4 finish.
 - 2) Concealed: No. 2B finish.
 - b. Pressure Class: Negative 4-inch wg
 - c. Minimum SMACNA Seal Class: Welded seams, joints, and penetrations.
- E. Outdoor-Air (Not Filtered, Heated, or Cooled) Ducts:
 - 1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:
 - a. Pressure Class: Positive or negative 1-inch wg.
 - b. Minimum SMACNA Seal Class: C.
- F. Intermediate Reinforcement:
 - 1. Galvanized-Steel Ducts: Galvanized steel.
 - 2. Stainless-Steel Ducts: Match duct material.

G. Liner:

1. Supply, Return, and Exhaust Air Ducts: Fibrous glass, 1 inch thick.
2. Supply Fan Plenums: Fibrous glass, 1 inch thick.
3. Return- and Exhaust-Fan Plenums: Fibrous glass, 2 inches thick.
4. Transfer Ducts: Fibrous glass, Type I, 1 inch thick.

H. Double-Wall Duct Interstitial Insulation:

1. Supply, return and exhaust Air Ducts: 1 inch thick.

I. Elbow Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
 - a. Velocity 1000 fpm or Lower:
 - 1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
 - 2) Mitered Type RE 4 without vanes.
 - b. Velocity 1000 to 1500 fpm:
 - 1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
 - 2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
 - 3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
 - c. Velocity 1500 fpm or Higher:
 - 1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
 - 2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
 - 3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
2. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
 - a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
 - b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
 - c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
3. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."

- a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
 - 1) Velocity 1000 fpm or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
 - 2) Velocity 1000 to 1500 fpm: 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
 - 3) Velocity 1500 fpm or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
 - 4) Radius-to Diameter Ratio: 1.5.
- b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
- c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam or Welded.

J. Branch Configuration:

- 1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."
 - a. Rectangular Main to Rectangular Branch: 45-degree entry.
 - b. Rectangular Main to Round Branch: Adjustable takeoff fitting.
- 2. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.
 - a. Velocity 1000 fpm or Lower: 90-degree tap.
 - b. Velocity 1000 to 1500 fpm: Conical tap.
 - c. Velocity 1500 fpm or Higher: 45-degree lateral.

END OF SECTION 233113

SECTION 233300 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

1. Manual volume dampers.
2. Control dampers.
3. Fire dampers.
4. Flange connectors.
5. Turning vanes.
6. Duct-mounted access doors.
7. Flexible connectors.
8. Flexible ducts.
9. Duct accessory hardware.

- B. Related Requirements:

1. Section "HVAC Gravity Ventilators" for roof-mounted ventilator caps.
2. Section "Digital, Addressable Fire-Alarm System" for duct-mounted fire and smoke detectors.
3. Section "Zoned (DC-Loop) Fire-Alarm System" for duct-mounted fire and smoke detectors.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

- B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.

1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:
 - a. Special fittings.
 - b. Manual volume damper installations.
 - c. Control-damper installations.

- d. Fire-damper, smoke-damper, combination fire- and smoke-damper, ceiling, and corridor damper installations, including sleeves; and duct-mounted access doors and remote damper operators.
- e. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from Installers of the items involved.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fusible Links: Furnish quantity equal to 10 percent of amount installed.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2.2 MATERIALS

- A. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
 - 1. Galvanized Coating Designation: G90.
 - 2. Exposed-Surface Finish: Mill phosphatized.
- B. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304, and having a No. 2 finish for concealed ducts and No. 3 finish for exposed ducts.
- C. Extruded Aluminum: Comply with ASTM B 221, Alloy 6063, Temper T6.

- D. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
- E. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.3 MANUAL VOLUME DAMPERS

A. Standard, Steel, Manual Volume Dampers:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. American Warming and Ventilating.
 - b. Flexmaster U.S.A., Inc.
 - c. McGill AirFlow LLC.
 - d. Metalaire
 - e. Nailor Industries Inc.
 - f. Pottorff.
 - g. Ruskin Company.
 - h. Vent Products Co., Inc.
2. Standard leakage rating, with linkage outside airstream.
3. Suitable for horizontal or vertical applications.
4. Frames:
 - a. Frame: Hat-shaped, 0.094-inch- thick, galvanized sheet steel.
 - b. Mitered and welded corners.
 - c. Flanges for attaching to walls and flangeless frames for installing in ducts.
5. Blades:
 - a. Multiple or single blade.
 - b. Parallel- or opposed-blade design.
 - c. Stiffen damper blades for stability.
 - d. Galvanized-steel, 0.064 inch thick.
6. Blade Axles: Galvanized steel.
7. Bearings:
 - a. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
8. Tie Bars and Brackets: Galvanized steel.

B. Jackshaft:

1. Size: 1-inch diameter.
2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.

3. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.

C. Damper Hardware:

1. Zinc-plated, die-cast core with dial and handle made of 3/32-inch- thick zinc-plated steel, and a 3/4-inch hexagon locking nut.
2. Include center hole to suit damper operating-rod size.
3. Include elevated platform for insulated duct mounting.

2.4 CONTROL DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. American Warming and Ventilating; a division of Mestek, Inc.
2. Arrow United Industries; a division of Mestek, Inc.
3. Cesco Products; a division of Mestek, Inc.
4. Greenheck Fan Corporation.
5. Lloyd Industries, Inc.
6. McGill AirFlow LLC.
7. Metalaire
8. Metal Form Manufacturing, Inc.
9. Nailor Industries Inc.
10. NCA Manufacturing, Inc.
11. Pottorff.
12. Ruskin Company.
13. Vent Products Company, Inc.
14. Young Regulator Company.

B. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.

C. Frames:

1. Hat shaped.
2. 0.094-inch- thick, galvanized sheet steel.
3. Mitered and welded corners.

D. Blades:

1. Multiple blade with maximum blade width of 8 inches.
2. Parallel- and opposed-blade design.
3. Galvanized-steel.
4. Blade Edging: Inflatable seal blade edging, or replaceable rubber seals.

E. Blade Axles: 1/2-inch- diameter; galvanized steel; blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings.

1. Operating Temperature Range: From minus 40 to plus 200 deg F.

- F. Bearings:
 - 1. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
 - 2. Thrust bearings at each end of every blade.

2.5 FIRE DAMPERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Air Balance Inc.; a division of Mestek, Inc.
 - 2. Arrow United Industries; a division of Mestek, Inc.
 - 3. Cesco Products; a division of Mestek, Inc.
 - 4. Greenheck Fan Corporation.
 - 5. Metalaire
 - 6. Nailor Industries Inc.
 - 7. NCA Manufacturing, Inc.
 - 8. Pottorff.
 - 9. Prefco; Perfect Air Control, Inc.
 - 10. Ruskin Company.
 - 11. Vent Products Company, Inc.
 - 12. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Type: Dynamic; rated and labeled according to UL 555 by an NRTL.
- C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 2000-fpm velocity. Dampers used on medium pressure (VAV systems) shall be rated for 3000 fpm and 8"wg static pressure.
- D. Fire Rating: 1-1/2 or 3 hours as indicated by the wall ratings on the architectural plans
- E. Frame: Curtain type with blades outside airstream; fabricated with roll-formed, 0.034-inch- thick galvanized steel; with mitered and interlocking corners.
- F. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.
 - 1. Minimum Thickness: 0.05 or 0.138 inch] thick, as indicated, and of length to suit application.
 - 2. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.
- G. Mounting Orientation: Vertical or horizontal as indicated.
- H. Blades: Roll-formed, interlocking, 0.024-inch-0.034-inch- thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- thick, galvanized-steel blade connectors.
- I. Horizontal Dampers: Include blade lock and stainless-steel closure spring.
- J. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.

2.6 FLANGE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Ductmate Industries, Inc.
 - 2. Nexus PDQ; Division of Shilco Holdings Inc.
 - 3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Description: Add-on or roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.
- C. Material: Galvanized steel.
- D. Gage and Shape: Match connecting ductwork.

2.7 TURNING VANES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Ductmate Industries, Inc.
 - 2. Duro Dyne Inc.
 - 3. Elgen Manufacturing.
 - 4. METALAIRE, Inc.
 - 5. SEMCO Incorporated.
 - 6. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
 - 1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.
- C. Manufactured Turning Vanes for Nonmetal Ducts: Fabricate curved blades of resin-bonded fiberglass with acrylic polymer coating; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
- D. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vanes and Vane Runners," and 4-4, "Vane Support in Elbows."
- E. Vane Construction: Single wall for ducts up to 48 inches wide and double wall for larger dimensions.

2.8 DUCT-MOUNTED ACCESS DOORS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. American Warming and Ventilating; a division of Mestek, Inc.
 - 2. Cesco Products; a division of Mestek, Inc.

3. Ductmate Industries, Inc.
4. Elgen Manufacturing.
5. Flexmaster U.S.A., Inc.
6. Greenheck Fan Corporation.
7. McGill AirFlow LLC.
8. Nailor Industries Inc.
9. Pottorff.
10. Ventfabrics, Inc.
11. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2, "Duct Access Doors and Panels," and 7-3, "Access Doors - Round Duct."

1. Door:
 - a. Double wall, rectangular.
 - b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
 - c. Vision panel where indicated.
 - d. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
 - e. Fabricate doors airtight and suitable for duct pressure class.
2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.

2.9 FLEXIBLE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Ductmate Industries, Inc.
2. Duro Dyne Inc.
3. Elgen Manufacturing.
4. Ventfabrics, Inc.
5. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Materials: Flame-retardant or noncombustible fabrics.

C. Coatings and Adhesives: Comply with UL 181, Class 1.

D. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to two strips of 2-3/4-inch- wide, 0.028-inch- thick, galvanized sheet steel or 0.032-inch- thick aluminum sheets. Provide metal compatible with connected ducts.

E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.

1. Minimum Weight: 26 oz./sq. yd..
2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
3. Service Temperature: Minus 40 to plus 200 deg F.

- F. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.
 - 1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
 - 2. Outdoor Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 - 3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 - 4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 - 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 - 6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
 - 7. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch movement at start and stop.

2.10 FLEXIBLE DUCTS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. ATCO.
 - 2. Flexmaster U.S.A., Inc.
 - 3. McGill AirFlow LLC.
 - 4. Thermaflex
 - 5. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Insulated, Flexible Duct: UL 181, Class 1, multiple layers of aluminum laminate supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene vapor-barrier film.
 - 1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
 - 2. Maximum Air Velocity: 4000 fpm.
 - 3. Temperature Range: Minus 20 to plus 210 deg F.
 - 4. Insulation R-value: 6.0.
- C. Flexible Duct Connectors:
 - 1. Clamps: Nylon strap in sizes 3 through 18 inches, to suit duct size.

2.11 DUCT ACCESSORY HARDWARE

- A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.
- B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.
- B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.
- C. Install backdraft dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.
- D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
 - 1. Install steel volume dampers in steel ducts.
- E. Set dampers to fully open position before testing, adjusting, and balancing.
- F. Install test holes at fan inlets and outlets and elsewhere as indicated.
- G. Install fire and smoke dampers according to UL listing.
- H. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
 - 1. On both sides of duct coils.
 - 2. Upstream from duct filters.
 - 3. At outdoor-air intakes and mixed-air plenums.
 - 4. At drain pans and seals.
 - 5. Downstream from, control dampers, backdraft dampers, and equipment.
 - 6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
 - 7. At each change in direction and at maximum 50-foot spacing.
 - 8. Upstream or downstream from duct silencers.
 - 9. Control devices requiring inspection.
 - 10. Elsewhere as indicated.
- I. Install access doors with swing against duct static pressure.
- J. Label access doors according to Section "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.
- K. Install flexible connectors to connect ducts to equipment.

- L. For fans developing static pressures of 5-inch wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.
- M. Connect diffusers to ducts with maximum 48-inch lengths of flexible duct clamped or strapped in place.
- N. Connect flexible ducts to metal ducts with draw bands.
- O. Install duct test holes where required for testing and balancing purposes.
- P. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop of fans.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Operate dampers to verify full range of movement.
2. Inspect locations of access doors and verify that purpose of access door can be performed.
3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
4. Inspect turning vanes for proper and secure installation.
5. Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION 233300

SECTION 233423 - HVAC POWER VENTILATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. High Plume Laboratory Exhaust Blower.
 - 2. Ceiling-mounted ventilators.

1.3 PERFORMANCE REQUIREMENTS

- A. Project Altitude: Base fan-performance ratings on sea level.
- B. Operating Limits: Classify according to AMCA 99.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Also include the following:
 - 1. Certified fan performance curves with system operating conditions indicated.
 - 2. Certified fan sound-power ratings.
 - 3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
 - 4. Material thickness and finishes, including color charts.
 - 5. Dampers, including housings, linkages, and operators.
 - 6. Roof curbs.
 - 7. Fan speed controllers.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For power ventilators to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Belts: One set(s) for each belt-driven unit.

1.7 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. AMCA Compliance: Fans shall have AMCA-Certified performance ratings and shall bear the AMCA-Certified Ratings Seal.
- C. UL Standards: Power ventilators shall comply with UL 705. Power ventilators for use for restaurant kitchen exhaust shall also comply with UL 762.

1.8 COORDINATION

- A. Coordinate size and location of structural-steel support members.
- B. Coordinate sizes and locations of concrete bases with actual equipment provided.
- C. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly indicating manufacturer, material, products included, and location of installation.
- B. Store materials in a dry area indoor, protected from damage, and in accordance with manufacturer's instructions. For long term storage, follow manufacturer's Installation, Operation and Maintenance manual.
- C. Handle and lift fans in accordance with the manufacturer's instructions. Protect materials and finishes during handling and installation to prevent damage. Follow all safety warnings posted by the manufacturer.

PART 2 - PRODUCTS

2.1 HIGH PLUME LABORATORY EXHAUST BLOWER

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Greenheck Fan Corporation
 2. Hartzell Fan Incorporated.
 3. Twin City

2.2 GENERAL

- A. Base fan performance at standard conditions (density 0.075 Lb. /ft³).
- B. Fans selected shall be capable of accommodating static pressure and flow variations of +/-15% of scheduled values.
- C. Each fan shall be belt driven.
- D. Each fan to be equipped with 316 stainless steel lifting lugs for corrosion resistance.
- E. Fasteners exposed to corrosive exhaust shall be stainless steel.
- F. Fan assembly shall be designed for a minimum of 125 MPH wind loading, without the use of guy wires.

2.3 CORROSION RESISTANT COATING

- A. All steel fan and system components (fan, nozzle, windband and plenum) shall be corrosion resistant coated with LabCoat™, a two part electrostatically applied and baked, sustainable, corrosion resistant coating system. Standard finish color to be RAL 7023, concrete grey.
- B. All parts shall be cleaned and chemically prepared for coating using a multi-stage wash system which includes acid pickling that removes oxide, increases surface area, and improves coating bond to the substrate.
- C. The first powder coat applied over the prepared surface shall be a zinc rich epoxy primer (no less than 70% zinc) and heated to a gelatinous consistency (partial cure) at which the second powder coat of polyester resin shall be electrostatically applied and simultaneously be cured at a uniform temperature of 400°F.
- D. The coating system, a total thickness of up to 6 mils, is not affected by the UV component of sunlight (does not chalk), and has superior corrosion resistance to acid, alkali, and solvents. Coating system shall exceed 4000 hour ASTM B117 Salt Spray Resistance.
- E. Note that 10-20 mil thick wet coating systems pollute the environment (air and water), and that these manually applied coatings are not uniform over the impeller surface and can cause fan imbalance and vibration.

2.4 FAN HOUSING AND OUTLET

- A. Fan housing to be aerodynamically designed with high-efficiency inlet, engineered to reduce incoming air turbulence.
- B. Fan housing shall be welded steel and meet specification section 2.15 for corrosion resistant coating. No uncoated metal fan parts shall be acceptable.
- C. Load bearing or structural fan components that are fabricated of polypropylene or fiberglass that have lower mechanical properties than steel, have rough interior surfaces in which corrosive,

hazardous compounds can collect, and / or which chalk and structurally degrade due to the UV component of the sunlight shall not be acceptable.

- D. A high velocity conical discharge nozzle shall be supplied by the fan manufacturer and be designed to efficiently handle an outlet velocity of up to 6000 FPM (30.48 m/s). Discharge nozzles shall be steel with corrosion resistant coating or chemical resistant medium density polyethylene with UV inhibitors to prevent chalking and have smooth interior surfaces. Discharge stack caps or hinged covers, impeding exhaust flow shall not be permitted.
- E. Provide housing drain for removal of rain and condensation.
- F. A bolted and gasketed access door shall be supplied in the fan housing allowing for servicing and cleaning. Access door can also be used for impeller inspection or removal of impeller, shaft and bearings without removal of the fan housing.

2.5 FAN IMPELLER

- A. Fan impeller shall be centrifugal, backward inclined, with non-stall characteristics. The impeller shall be electronically balanced both statically and dynamically per AMCA Standard 204.
- B. Fan impeller shall be manufactured of aluminum (AMCA type B spark resistant), fully welded and meet specification section 2.15 for corrosion resistant coating.

2.6 FAN BYPASS AIR PLENUM

- A. For constant volume systems, the fan shall be connected directly to the exhaust duct without the need of a bypass air plenum. Fans mounted directly to roof curbs shall be provided with a damper tray located in the roof curb for mounting of the gravity isolation damper.
- B. The plenum shall be constructed of fully welded steel, meet specification section 2.15 for corrosion resistant coating, and mount on roof curb as shown on the project drawings. Plenum to include clean-out access door for cleaning the inlet venturi and inlet duct. Plenums that are fabricated of plastics or resins that are combustible and have mechanical properties less than steel shall not be acceptable.
- C. The bypass air plenum shall be mounted on factory fabricated roof curb provided by the fan manufacturer, as shown on the project drawings
- D. Fan designs that use inlet flexible connectors that can leak causing loss of lab exhaust shall not be accepted.
- E. Bypass air dampers shall be opposed-blade design, and coated with up to 4 mils of Hi-Pro Polyester resin, electrostatically applied and baked.
- F. A fan isolation damper, either gravity backdraft or two position actuated, fabricated of steel or aluminum and coated with minimum 4 mils of Hi-Pro Polyester resin, electrostatically applied and baked, shall be provided as shown on the project documents.
- G. Blower / Plenum vibration isolation shall be limited to neoprene / cork vibration pads.

H. BYPASS AIR PLENUM CURB

- I. Exhaust system manufacturer shall supply a structural support curb for the plenum, of specified height, as shown on the drawings.
- J. Curb shall be fabricated of a minimum of 14 gauge of galvanized corrosion resistant coated steel and structurally reinforced.
- K. Curbs shall be insulated.
- L. When properly anchored to the roof structure, the standard curb / plenum / blower assembly shall withstand wind loads of up to 125 mph without additional structural support.

2.7 FAN MOTORS AND DRIVE

- A. Motors shall be premium efficiency, standard NEMA frame, 1800 or 3600 RPM, Totally Enclosed Fan Cooled (TEFC) Explosion Proof (EXP) with a 1.15 service factor. A factory-mounted NEMA 3R disconnect switch shall be provided for each fan. Motor maintenance shall be accomplished without fan impeller removal or requiring maintenance personnel to access the contaminated exhaust components.
- B. Drive belts and sheaves shall be sized for 200% of the motor horsepower, and shall be readily and easily accessible for service, if required. Drive shall consist of a minimum of two belts under all circumstances.
- C. Fan shaft to be turned and polished of 316 stainless steel as standard, coated with corrosion resistant coating.
- D. Fan shaft bearings shall be Air Handling Quality, ball or roller pillow block type and be sized for an L-10 life of no less than 100,000 hours. Bearings shall be fixed to the fan shaft using concentric mounting locking collars, which reduce vibration, increase service life, and improve serviceability. Bearings that use set screws shall not be allowed.
- E. All shaft bearings shall have extended lube lines with Zerk fittings.

2.8 CEILING-MOUNTED VENTILATORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Acme
 - 2. Barry Blower
 - 3. Breidert Air Products.
 - 4. Broan-NuTone LLC.
 - 5. Carnes Company.
 - 6. Cincinnati Fan & Ventilator Co.
 - 7. Greenheck Fan Corporation.
 - 8. Loren Cook Company.
 - 9. PennBarry.

10. Twin City

- B. Housing: Steel, lined with acoustical insulation. Furnish inline configuration where indicated on the drawings.
- C. Fan Wheel: Centrifugal wheels directly mounted on motor shaft. Fan shrouds, motor, and fan wheel shall be removable for service.
- D. Grille: Plastic, louvered grille with flange on intake and thumbscrew attachment to fan housing.
- E. Electrical Requirements: Junction box for electrical connection on housing and receptacle for motor plug-in.
- F. Accessories:
 - 1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
 - 2. Manual Starter Switch: Single-pole rocker switch assembly with cover and pilot light.
 - 3. Manufacturer's standard roof jack or wall cap, and transition fittings as indicated on the drawings.

2.9 MOTORS

- A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section "Common Motor Requirements for HVAC Equipment."
 - 1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
- B. Enclosure Type: Totally enclosed, fan cooled.

2.10 SOURCE QUALITY CONTROL

- A. Certify sound-power level ratings according to AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.
- B. Certify fan performance ratings, including flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating." Label fans with the AMCA-Certified Ratings Seal.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install power ventilators level and plumb.
- B. Equipment Mounting:
 - 1. Install power ventilators on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section "Cast-in-Place Concrete." and/or Section "Miscellaneous Cast-in-Place Concrete."
 - 2. Comply with requirements for vibration isolation devices specified in Section "Vibration Controls for HVAC."
- C. Secure roof-mounted fans to roof curbs with cadmium-plated hardware. See Section "Roof Accessories" for installation of roof curbs.
- D. Ceiling Units: Suspend units from structure; use steel wire or metal straps.
- E. Support suspended units from structure using threaded steel rods and spring hangers having a static deflection of 1 inch deflection.
- F. Install units with clearances for service and maintenance.
- G. Label units according to requirements specified in Section "Identification for HVAC Piping and Equipment."

3.2 CONNECTIONS

- A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section "Air Duct Accessories."
- B. Install ducts adjacent to power ventilators to allow service and maintenance.
- C. Ground equipment according to Section "Grounding and Bonding for Electrical Systems."
- D. Connect wiring according to Section "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:

1. Verify that shipping, blocking, and bracing are removed.
2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
3. Verify that cleaning and adjusting are complete.
4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
5. Adjust belt tension.
6. Adjust damper linkages for proper damper operation.
7. Verify lubrication for bearings and other moving parts.
8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
9. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
10. Shut unit down and reconnect automatic temperature-control operators.
11. Remove and replace malfunctioning units and retest as specified above.

C. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Prepare test and inspection reports.

3.4 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust belt tension.

C. Comply with requirements in Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.

D. Replace fan and motor pulleys as required to achieve design airflow.

E. Lubricate bearings.

3.5 DEMONSTRATION

A. Train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventive maintenance. Schedule training with Owner, through Architect, with at least 7 days' advance notice.

B. Review data in the operation and maintenance manuals.

END OF SECTION 233423

SECTION 233713 - DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.

1.2 SUMMARY

- A. This Section includes ceiling and wall mounted diffusers, registers, grilles and exterior louvers.
- B. Related Sections:
 - 1. Section "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated, include the following:
 - 1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
 - 2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

PART 2 - PRODUCTS

2.1 CEILING DIFFUSERS, REGISTERS AND GRILLES

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Anemostat Products; a Mestek company.
 - b. Carnes.
 - c. Hart & Cooley Inc.
 - d. Krueger
 - e. METALAIRE, Inc.
 - f. Nailor Industries Inc.
 - g. Price Industries.
 - h. Titus.
 - i. Tuttle & Bailey.

2.2 EXTERIOR LOUVERS

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Arrow
 - b. Greenheck
 - c. Louvers & Dampers
 - d. United Enertech
 - e. Vent Products
 - f. Ruskin
2. Depth: 6 inches.

2.3 SOURCE QUALITY CONTROL

- A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install diffusers, registers, and grilles level and plumb.
- B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.
- C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.
- D. After installation of diffusers, registers, grilles and louvers, inspect exposed finish. Clean exposed surfaces to remove burrs, dirt, and smudges. Replace diffusers, registers, and grilles that have damaged finishes.

3.3 ADJUSTING

- A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 233713

SECTION 233723 - HVAC GRAVITY VENTILATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

- 1. Roof hoods.

1.3 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design ventilators, including comprehensive engineering analysis by a qualified professional engineer, using structural performance requirements and design criteria indicated.
- B. Structural Performance: Ventilators shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without permanent deformation of ventilator components, noise or metal fatigue caused by ventilator blade rattle or flutter, or permanent damage to fasteners and anchors. Wind pressures shall be considered to act normal to the face of the building.
 - 1. Wind Loads: Determine loads based on pressures as indicated on Drawings.
- C. Water Entrainment: Limit water penetration through unit to comply with ASHRAE 62.1.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For gravity ventilators. Include plans, elevations, sections, details, ventilator attachments to curbs, and curb attachments to roof structure.
 - 1. Show weep paths, gaskets, flashing, sealant, and other means of preventing water intrusion.
- C. Samples: For each exposed product and for each color and texture specified.
- D. Samples for Initial Selection: For units with factory-applied color finishes.

- E. Samples for Verification: For each type of louvered-penthouse ventilator indicated, in manufacturer's standard size.
- F. Delegated-Design Submittal: For shop-fabricated ventilators indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - 1. Detail fabrication and assembly of shop-fabricated ventilators.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Roof framing plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
 - 1. Structural members to which roof curbs and ventilators will be attached.
 - 2. Sizes and locations of roof openings.
- B. Welding certificates.

1.6 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to the following:
 - 1. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
 - 2. AWS D1.3, "Structural Welding Code - Sheet Steel."

1.7 COORDINATION

- A. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Aluminum Extrusions: ASTM B 221, Alloy 6063-T5 or T-52.
- B. Aluminum Sheet: ASTM B 209, Alloy 3003 or 5005 with temper as required for forming or as otherwise recommended by metal producer for required finish.
- C. Galvanized-Steel Sheet: ASTM A 653/A 653M, G90 zinc coating, mill phosphatized.
- D. Stainless-Steel Sheet: ASTM A 666, Type 304, with No. [4] [6] finish.
- E. Fasteners: Same basic metal and alloy as fastened metal or 300 Series stainless steel unless otherwise indicated. Do not use metals that are incompatible with joined materials.

1. Use types and sizes to suit unit installation conditions.
 2. Use hex-head or Phillips pan-head screws for exposed fasteners unless otherwise indicated.
- F. Post-Installed Fasteners for Concrete and Masonry: Torque-controlled expansion anchors made from stainless-steel components, with capability to sustain without failure a load equal to 4 times the loads imposed for concrete, or 6 times the load imposed for masonry, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.
- G. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.2 FABRICATION, GENERAL

- A. Factory or shop fabricate gravity ventilators to minimize field splicing and assembly. Disassemble units to the minimum extent as necessary for shipping and handling. Clearly mark units for reassembly and coordinated installation.
- B. Fabricate frames, including integral bases, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.
- C. Fabricate units with closely fitted joints and exposed connections accurately located and secured.
- D. Fabricate supports, anchorages, and accessories required for complete assembly.
- E. Perform shop welding by AWS-certified procedures and personnel.

2.3 ROOF HOODS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Acme Engineering & Mfg. Corporation.
 2. Aerovent.
 3. Carnes.
 4. Greenheck Fan Corporation.
 5. JencoFan.
 6. Loren Cook Company.
 7. PennBarry.
- B. Factory or shop fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figures 6-6 and 6-7.
- C. Materials: Heavy Gage Aluminum construction suitably reinforced and corrosion resistant.
- D. Roof Curbs: Galvanized-steel sheet; with mitered and welded corners; 1-1/2-inch- thick, rigid fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to fit roof opening and ventilator base.

1. Configuration: Self-flashing without a cant strip, with mounting flange.
 2. Overall Height: 12 inches above roof surface.
- E. Insect Screening: Aluminum, 18-by-16 mesh, 0.012-inch wire.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install gravity ventilators level, plumb, and at indicated alignment with adjacent work. Secure ventilator to roof curb with cadmium plated screws, minimum two per side.
- B. Install gravity ventilators with clearances for service and maintenance.
- C. Install perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.
- D. Install concealed gaskets, flashings, joint fillers, and insulation as installation progresses. Comply with Section "Joint Sealants" for sealants applied during installation.
- E. Label gravity ventilators according to requirements specified in Section "Identification for HVAC Piping and Equipment."
- F. Protect galvanized and nonferrous-metal surfaces from corrosion or galvanic action by applying a heavy coating of bituminous paint on surfaces that will be in contact with concrete, masonry, or dissimilar metals.
- G. Repair finishes damaged by cutting, welding, soldering, and grinding. Restore finishes so no evidence remains of corrective work. Return items that cannot be refinished in the field to the factory, make required alterations, and refinish entire unit or provide new units.

3.2 CONNECTIONS

- A. Duct installation and connection requirements are specified in Section "Metal Ducts" and Section "Nonmetal Ducts." Drawings indicate general arrangement of ducts and duct accessories.

3.3 ADJUSTING

- A. Adjust damper linkages for proper damper operation.

END OF SECTION 233723

SECTION 237433 - DEDICATED OUTDOOR-AIR UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes factory-packaged units capable of supplying up to 100 percent outdoor air and providing cooling and heating.

1.3 QUALITY ASSURANCE

- A. Unit shall be certified in accordance with UL Standard 1995/CSA C22.2 No. 236, Safety Standard for Heating and Cooling Equipment.
- B. Unit and refrigeration system shall comply with ASHRAE 15, Safety Standard for Mechanical Refrigeration.
- C. Unit Seasonal Energy Efficiency Ratio (SEER) shall be equal to or greater that prescribed by ASHRAE 90.1, Energy Efficient Design of New Buildings except Low-Rise Residential Buildings.
- D. Unit shall be safety certified by ETL and ETL US listed.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include rated capacities, operating characteristics, and furnished specialties and accessories.
- B. Shop Drawings:
 - 1. Include plans, elevations, sections, and attachment details.
 - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Prepare the following by or under the supervision of a qualified professional engineer:
 - a. Mounting Details: For securing and flashing roof curb to roof structure. Indicate coordinating requirements with roof membrane system.
 - b. Include diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Roof-curb mounting details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Size and location of unit-mounted rails and anchor points and methods for anchoring units to roof curb.
- B. Startup service reports.
- C. Sample Warranty: For special warranty.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Unit shall be shipped with doors bolted shut and outside air hood closed to prevent damage during transport and thereafter while in storage awaiting installation.
- B. Follow Installation, Operation and Maintenance manual instructions for rigging, moving, and unloading the unit at its final location.
- C. Unit shall be stored in a clean, dry place protected from construction traffic in accordance with the Installation, Operation and Maintenance manual.

1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For units to include in emergency, operation, and maintenance manuals.

1.8 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Filters: One set for each unit.

1.9 WARRANTY

- A. Special Warranty: Manufacturer agrees to replace components of units that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period for Compressors: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Aeon
 - 2. Addison.
 - 3. Desert Aire.
 - 4. Munters
 - 5. Reznor.

2.2 GENERAL DESCRIPTION

- A. Packaged rooftop unit shall include compressor, evaporator coil, filters, supply fan, dampers, air-cooled condenser coils, condenser fan, reheat coil, electric heater, and unit controls.
- B. Unit shall be factory assembled and tested including leak testing of the DX coils, pressure testing of the refrigeration circuit, and run testing of the completed unit. Run test report shall be supplied with the unit in the service compartment's literature pocket.
- C. Unit shall have decals and tags to indicate lifting and rigging, service areas and caution areas for safety and to assist service personnel.
- D. Unit components shall be labeled, including refrigeration system components and electrical and controls components.
- E. Estimated sound power levels (dB) shall be shown on the unit ratings sheet.
- F. Installation, Operation and Maintenance manual shall be supplied within the unit.
- G. Laminated color-coded wiring diagram shall match factory installed wiring and shall be affixed to the interior of the control compartment's hinged access door.
- H. Unit nameplate shall be provided in two locations on the unit, affixed to the exterior of the unit and affixed to the interior of the control compartment's hinged access door.

2.3 PERFORMANCE REQUIREMENTS

- A. General Fabrication Requirements: Comply with requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment," and Section 7 - "Construction and System Start-up."
- B. Cabinet Thermal Performance:
 - 1. Maximum Overall R-Value: 13.
 - 2. Include effects of metal-to-metal contact and thermal bridges in the calculations.
- C. Cabinet Surface Condensation:

1. Cabinet shall have additional insulation and vapor seals if required to prevent condensation on the interior and exterior of the cabinet.
 2. Portions of cabinet located downstream from the cooling coil shall have a thermal break at each thermal bridge between the exterior and interior casing to prevent condensation from occurring on the interior and exterior surfaces. The thermal break shall not compromise the structural integrity of the cabinet.
- D. Maximum Cabinet Leakage: 1 percent of the total supply-air flow at a pressure rating equal to three times the maximum external static pressure.
- E. Cabinet Deflection Performance:
1. Walls and roof deflection shall be within 1/240 of the span at the design working pressure equal to the fan shut-off pressure. Deflection limits shall be measured at any point on the surface.
 2. Floor deflections shall be within 1/240 of the span considering the worst-case condition caused by the following:
 - a. Service personnel.
 - b. Internal components.
 - c. Design working pressure defined for the walls and roof.
- F. Electrical components, devices, and accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.4 CABINET

- A. Construction: Double wall.
- B. Exterior Casing Material: G90 Galvanized steel with paint finish. Exterior paint finish shall be capable of withstanding at least 2,500 hours, with no visible corrosive effects, when tested in a salt spray and fog atmosphere in accordance with ASTM B 117-95 test procedure.
- C. Interior Casing Material: G90 Galvanized steel.
- D. Lifting and Handling Provisions: Factory-installed shipping skids and lifting lugs.
- E. Base Rails: Galvanized-steel rails for mounting on roof curb or pad as indicated.
- F. Access for Inspection, Cleaning, and Maintenance: Comply with requirements in ASHRAE 62.1.
- G. Service Doors: Hinged access doors with gaskets. Material and construction of doors shall match material and construction of cabinet in which doors are installed.
- H. Roof: air tunnel shall be sloped to provide complete drainage. Cabinet shall have rain break overhangs above access doors.
- I. Floor: Reinforced, metal surface; reinforced to limit deflection when walked on by service personnel. Insulation shall be below metal walking surface.

- J. Cabinet Insulation: Unit insulation shall have a minimum thermal resistance R-value of 13. Foam insulation shall have a minimum density of 2 pounds/cubic foot and shall be tested in accordance with ASTM D-1929 for a minimum flash ignition temperature of 610°F.
- K. Condensate Drain Pans:
 - 1. Shape: Rectangular, with 1 percent slope in at least two planes to direct water toward drain connection.
 - 2. Size: Large enough to collect condensate from cooling coils including coil piping connections, coil headers, and return bends.
 - a. Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
 - b. Depth: A minimum of 2 inches deep.
 - 3. Material: Type 304 Stainless-steel sheet.
 - 4. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.
- L. Surfaces in Contact with Airstream: Comply with requirements in ASHRAE 62.1 for resistance to mold and erosion.
- M. Access to filters, dampers, cooling coil, reheat coil, heater, compressor, and electrical and controls components shall be through hinged access doors with quarter turn, lockable handles. Full length stainless steel piano hinges shall be included on the doors.
- N. Unit shall be provided with left side horizontal discharge and return air openings. All openings through the unit shall have upturned flanges of at least 1/2 inch around the opening.
- O. Unit shall include lifting lugs on the top of the unit.
- P. Unit shall include interior corrosion protection which shall be capable of withstanding at least 2,500 hours, with no visible corrosive effects, when tested in a salt spray and fog atmosphere in accordance with ASTM B 117-95 test procedure. Air tunnel, fans and dampers shall all include the corrosion protection.

2.5 SUPPLY FAN

- A. Plenum Fan Type: Single width, non-overloading, with backward-inclined or airfoil blades.
- B. Blowers and motors shall be dynamically balanced.
- C. Motor shall be a high efficiency electrically commutated motor.

2.6 COOLING COILS

- A. Capacity Ratings: Comply with ASHRAE 33 and ARI 410.
- B. Evaporator Coils

1. Coils shall be designed for use with R-410A refrigerant and constructed of copper tubes with aluminum fins mechanically bonded to the tubes and aluminum end casings. Fin design shall be sine wave rippled.
2. Coil shall be standard capacity
3. Coils shall be helium hydrogen or helium leak tested.
4. Coils shall be furnished with factory installed electronic expansion valves.
5. Coils shall have a flexible, epoxy polymer e-coat uniformly applied to all coil surface areas without material bridging between fins. Humidity and water immersion resistance shall be up to a minimum 1,000 and 250 hours respectively (ASTM D2247-92 and ASTM D870-92). Corrosion durability shall be confirmed through testing to no less than 6,000 hours salt spray per ASTM B117-90. Coated coils shall receive a spray-applied, UV-resistant polyurethane topcoat to prevent UV degradation of the e-coat. Coating shall carry a 5-year warranty, from the date of original equipment shipment from the factory. The first 12 months from the date of equipment startup, or 18 months from the date of original equipment shipment from the factory, whichever is less, shall be covered under the standard limited parts warranty.

2.7 REFRIGERATION SYSTEM

- A. Comply with requirements in ASHRAE 15, "Safety Standard for Refrigeration Systems."
- B. Refrigerant Charge: Factory charged with refrigerant and filled with oil.
- C. Refrigerant: R-410A.
 1. Classified as Safety Group A1 according to ASHRAE 34.
 2. Provide unit with operating charge of refrigerant.
- D. Compressors: Compressors shall be scroll type with thermal overload protection and carry a 5 year non-prorated warranty, from the date of original equipment shipment from the factory.
 1. Compressors shall be mounted in an isolated service compartment which can be accessed without affecting unit operation. Lockable hinged compressor access doors shall be fabricated of double wall, rigid polyurethane foam injected panels to prevent the transmission of noise outside the cabinet.
 2. Compressors shall be isolated from the base pan with the compressor manufacturer's recommended rubber vibration isolators, to reduce any transmission of noise from the compressors into the building area.
 3. Each refrigeration circuit shall be equipped with thermostatic expansion valve type refrigerant flow control.
 4. Each refrigeration circuit shall be equipped with automatic reset low pressure and manual reset high pressure refrigerant safety controls, Schrader type service fittings on both the high pressure and low pressure sides and a factory installed replaceable core liquid line filter driers.
 5. Unit shall include a variable capacity scroll compressor on the refrigeration circuit which shall be capable of modulation from 10-100% of its capacity.
 6. Refrigeration circuit shall be provided with hot gas reheat coil, modulating valves, electronic controller, supply air temperature sensor and a control signal terminal which allow the unit to have a dehumidification mode of operation, which includes supply air

temperature control to prevent supply air temperature swings and overcooling of the space.

7. Unit shall be configured as an air-source heat pump. Refrigeration circuit shall be equipped with a factory installed liquid line filter drier with check valve, reversing valve, accumulator, and thermal expansion valves on both the indoor and outdoor coils. Reversing valve shall energize during the heat pump cooling mode of operation.
8. Refrigeration circuit shall be equipped with a liquid line sight glass.

E. Air-Cooled Condenser

1. Condenser fans shall be a vertical discharge, axial flow, direct drive fans.
2. Coils shall be designed for use with R-410A refrigerant.
3. Heat pump outdoor coil shall be constructed of copper tubes with aluminum fins mechanically bonded to the tubes and aluminum end casings. Fin design shall be sine wave rippled.
4. Coils shall be designed for a minimum of 10°F of refrigerant sub-cooling.
5. Coils shall be hydrogen or helium leak tested.
6. Condenser fans shall be high efficiency electrically commutated motor driven with factory installed head pressure control module. Condenser airflow shall continuously modulate based on head pressure and cooling operation shall be allowed down to 35°F with adjustable compressor lockout.
7. Coils shall have a flexible, epoxy polymer e-coat uniformly applied to all coil surface areas without material bridging between fins. Humidity and water immersion resistance shall be up to a minimum 1,000 and 250 hours respectively (ASTM D2247-92 and ASTM D870-92). Corrosion durability shall be confirmed through testing to no less than 6,000 hours salt spray per ASTM B117-90. Coated coils shall receive a spray-applied, UV-resistant polyurethane top coat to prevent UV degradation of the e-coat. Coating shall carry a 5-year warranty, from the date of original equipment shipment from the factory. The first 12 months from the date of equipment startup, or 18 months from the date of original equipment shipment from the factory, whichever is less, shall be covered under the standard limited parts warranty.

2.8 ELECTRIC-RESISTANCE HEATING COIL

- A. UL Compliance: Comply with requirements in UL 1995, "Heating and Cooling Equipment."
- B. Unit shall include an electric heater consisting of electric heating coils, fuses and a high temperature limit switch, with capacities as shown on the plans.
- C. Unit shall include 1 stage of capacity control.
- D. Electric heating coils shall be in the reheat position downstream of the cooling coil.
- E. Auxiliary electric heating capacity shall be sized to meet heating leaving air temperature setpoint when heat pump heating is in operation. Auxiliary heating capacity shall be available for operation when heat pump heating is in operation. Unit shall include 1 stage of auxiliary electric heating capacity.
- F. Emergency electric heating capacity shall be sized to meet heating leaving air temperature setpoint when heat pump heating is not in operation. Auxiliary electric heating capacity shall be

sized to meet heating leaving air temperature setpoint when heat pump heating is in operation. Unit shall include 1 stage of auxiliary electric heating capacity.

2.9 OUTDOOR-AIR INTAKE HOOD

- A. Type: Manufacturer's standard hood or louver.
- B. Materials: Match cabinet.
- C. Unit shall include 100% motor operated outside air damper assembly constructed of extruded aluminum, hollow core, airfoil blades with rubber edge seals and aluminum end seals. Damper blades shall be gear driven and designed to have no more than 15 cfm of leakage per sq. ft. of damper area when subjected to 2 inches w.g. air pressure differential across the damper. Damper assembly shall be controlled by spring return, 2 position actuator. Unit shall include outside air opening bird screen and outside air hood with rain lip.

2.10 FILTERS

- A. Unit shall include 2-inch-thick, pleated panel filters with an ASHRAE efficiency of 30% and MERV rating of 8, upstream of the cooling coil.
- B. Unit shall include 1 inch aluminum mesh pre-filters upstream of the outside air opening.

2.11 ELECTRICAL POWER CONNECTIONS

- A. General Electrical Power Connection Requirements: Factory-installed and -wired switches, motor controllers, transformers, and other necessary electrical devices shall provide a single-point field power connection to unit.
 - 1. Unit shall be provided with factory installed and factory wired, non-fused disconnect switch.
 - 2. Air-source heat pump shall include a defrost cycle to prevent frost accumulation on the outdoor coil during heat pump heating operation. Defrost cycle shall begin when outdoor coil temperature is below a fixed setpoint and have a fixed 10-minute run time, or end when the outdoor coil temperature is above a fixed setpoint. Defrost timer, with 30/60/90 minute selectable defrost cycle interval time, shall be factory installed in the controls compartment. During defrost cycle all compressors shall energize, reversing valve shall de-energize, and auxiliary heat shall energize.
 - 3. Unit shall be provided with a factory installed and factory wired 115V, 12 amp GFI outlet disconnect switch in the unit control panel.
 - 4. Unit shall be provided with phase and brown out protection which shuts down all motors in the unit if the electrical phases are more than 10% out of balance on voltage, the voltage is more than 10% under design voltage or on phase reversal.

2.12 CONTROLS

A. Furnish Factory Installed Controller consisting of the following:

1. Unit controller shall be capable of controlling all features and options of the unit to obtain sequence of operation. Controller shall be factory installed in the unit controls compartment and factory tested.
2. Controller shall be capable of standalone operation with unit configuration, setpoint adjustment, sensor status viewing, unit alarm viewing, and occupancy scheduling available without dependence on a building management system.
3. Controller shall have an onboard clock and calendar functions that allow for occupancy scheduling.
4. Controller shall include non-volatile memory to retain all programmed values without the use of a battery, in the event of a power failure.
5. Makeup Air Controller with Space Temperature and Humidity Reset
 - a. Unit shall modulate cooling with constant airflow to meet ventilation outside air loads. Cooling capacity shall modulate based on supply air temperature.
 - b. With modulating hot gas reheat, unit shall modulate cooling and hot gas reheat as efficiently as possible, to meet outside air humidity loads and prevent supply air temperature swings and overcooling of the space
 - c. Unit shall modulate heating with constant airflow to meet ventilation outside air loads. Heating capacity shall modulate based on supply air temperature.
6. Unit configuration, setpoint adjustment, sensor status viewing, unit alarm viewing, and occupancy scheduling shall be accomplished with connection to interface module with LCD screen and input keypad, interface module with touch screen, or with connection to PC with configuration software. Controller shall be capable of connection with other factory installed and factory provided unit controllers with individual unit configuration, setpoint adjustment, sensor status viewing, and occupancy scheduling available from a single unit. Connection between unit controllers shall be with a modular cable. Controller shall be capable of communicating and integrating with a BACnet network.

2.13 SEQUENCE OF OPERATION

A. Occupied Mode Sequence

1. Supply Fan Control (Constant Air Volume) - The supply fan runs continuously when fume hood is operating thru an interlock on fume hood starter. The supply fan is maintained by minimum on and off timers.
2. Heating Mode (Discharge Air Control 100% OA Heat Pump) - The heating mode will be enabled when the outside air temperature falls below the outside air heating setpoint minus hysteresis and the unit is not in dehumidification mode. During the heating mode,

the DDC controller will modulate and/or stage heating to maintain the supply air heating setpoint. Compressor heating will be used as the primary heating source as long as the outside air temperature is above the outside air temperature heat pump lockout setpoint. If enabled, auxiliary heating stages will be activated as needed to supplement compressor heating. If compressor heating is locked out due to outside air temperature, auxiliary heating will become the primary heating source. The heating mode will remain active until the outside air temperature rises above the outside air heating setpoint plus hysteresis. Heating stages are maintained by adjustable minimum on, off, stage up and stage down timers.

3. Cooling Mode Discharge Air Control (100% OA) - The cooling mode will be enabled when the outside air temperature rises above the outside air cooling setpoint plus hysteresis. During the cooling mode, the DDC controller will modulate and/or stage cooling to maintain the supply air cooling setpoint. The cooling mode will remain active until the outside air temperature falls below the outside air cooling setpoint minus hysteresis. Cooling stages are maintained by adjustable minimum on, off, stage up and stage down timers.
 4. Dehumidification Mode Discharge Air Control (100% OA) -The dehumidification mode will be enabled anytime the outside air dewpoint rises above the supply air dewpoint setpoint plus hysteresis. During the dehumidification mode, the DDC controller will modulate and/or stage cooling to maintain the supply air dewpoint setpoint. The dehumidification mode will remain active until the outside air dewpoint falls below the supply air dewpoint setpoint minus hysteresis. Reheat will be modulated and/or staged to maintain the supply air cooling setpoint minus 1°F.
 5. Supply Air Reset - The supply air cooling, heating and dehumidification setpoints shall be reset based on space temperature and relative humidity.
- B. Unoccupied Mode Sequence - The supply fan is off but activates on a call for any mode. The space temperature sensor will be used for unoccupied heating and cooling demands and will be based on space heating and cooling night setback setpoints. Space dewpoint will be used for unoccupied dehumidification and humidification demands and will be based on space dehumidification and humidification night setback setpoints. The supply fan will be activated on a call for any of the above modes of operation.
- C. Supply Fan Status - The supply fan status input must be CLOSED for mechanical heating or cooling to operate. If this input opens during normal operation, all mechanical heating and cooling outputs will be deactivated within 10 seconds.
- D. Emergency Shutdown - The emergency shutdown input must be CLOSED for normal operation. If this input is OPEN, no outputs on the controller will be activated. If this input opens during normal operation, all of the controller outputs will be deactivated within 10 seconds.
- E. Dirty Filter - If the dirty filter input closes during supply fan operation, an alarm will be generated indicating the filters need to be changed.
- F. Freeze Protection - If the supply air temperature falls below the freeze protection limit (default 35°F) and the freeze protection timer expires (default 10 minutes), all outputs will be

deactivated. Normal operation will be restored when the supply air temperature rises above the freeze protection limit by 5°F.

- G. Suction Pressure Protection - Suction pressure is used to unload the cooling and dehumidification PID loops to protect against coil freezing. If the suction pressure falls under 93psi for up to 5min for any compressor, that compressor will be disabled. The compressor must remain off for 5min before allowed to restart. If a compressor is disabled three times within an hour, that compressor will be locked out and power must be cycled to release the lockout.
- H. Heat Pump Defrost Mode - If the defrost thermostat input closes during compressor heating mode and the defrost interval has expired (60min), the reversing valve will switch the unit into the cooling mode and disable the condenser fan(s). The defrost mode will run until either the defrost timer has expired (10min) or the defrost thermostat opens. For discharge air temperature controlled applications; during the heat pump defrost mode, auxiliary heating, if enabled, will be activated as need to maintain the supply air temperature at the supply air temperature setpoint.
- I. Head Pressure Control Air Cooled Condensers:
 - 1. A discharge pressure transducer will be monitored on each compressor or refrigerant circuit. The condenser fan signal (VFD or ECM) is modulated to maintain 110F (365psi) condensing temperature during the cooling and dehumidification modes. The condenser fan signal range is from 20% minimum to 100% maximum. If head pressure should climb to over 130F (475psi) rapidly the condenser fans will be forced to 100% until the head pressure falls back to setpoint.
 - 2. On heat pumps units, the condenser fans run at full speed to during the heating mode. During defrost the condenser fan signal minimum drops to 0%, turning the fans off. If the head pressure rises above 130F (475psi), the PID loop will begin to ramp up to prevent unnecessary head pressure trips during a potential false defrost stat closure.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for piping, ducts, and electrical systems to verify actual locations of connections before equipment installation.
- C. Examine equipment supports for suitable conditions where units will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Comply with manufacturer's rigging and installation instructions for unloading units and moving to final locations.
- B. Equipment Mounting:
 - 1. Install air units on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section "Cast-in-Place Concrete."
 - 2. Comply with requirements for vibration isolation devices specified in Section "Vibration Controls for HVAC."
- C. Install wall- and duct-mounted sensors furnished by manufacturer for field installation. Install control wiring and make final connections to control devices and unit control panel.
- D. Install 3000-psi, compressive-strength (28-day) concrete base inside roof curb, 4 inches thick. Concrete and reinforcement are specified with concrete.
- E. Install separate devices furnished by manufacturer and not factory installed.
- F. Install new filters at completion of equipment installation and before testing, adjusting, and balancing.
- G. Install drain pipes from unit drain pans to sanitary drain.
 - 1. Drain Piping: Drawn-temper copper water tubing complying with ASTM B 88, Type L, with soldered joints.
 - 2. Pipe Size: Same size as condensate drain pan connection.

3.3 CONNECTIONS

- A. Where installing piping adjacent to units, allow space for service and maintenance.
- B. Duct Connections:
 - 1. Comply with requirements in Section "Metal Ducts."
 - 2. Drawings indicate the general arrangement of ducts.
 - 3. Connect ducts to units with flexible duct connectors. Comply with requirements for flexible duct connectors in Section "Air Duct Accessories."
- C. Electrical Connections: Comply with requirements for power wiring, switches, and motor controls in electrical Sections.
 - 1. Install electrical devices furnished by unit manufacturer but not factory mounted.

3.4 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
 2. Inspect units for visible damage to furnace combustion chamber.
 3. Inspect units for visible damage to refrigerant compressor, condenser and evaporator coils, and fans.
 4. Start refrigeration system when outdoor-air temperature is within normal operating limits and measure and record the following:
 - a. Cooling coil leaving-air, dry- and wet-bulb temperatures.
 - b. Cooling coil entering-air, dry- and wet-bulb temperatures.
 - c. Condenser coil entering-air dry-bulb temperature.
 - d. Condenser coil leaving-air dry-bulb temperature.
 5. Simulate maximum cooling demand and inspect the following:
 - a. Compressor refrigerant suction and hot-gas pressures.
 - b. Short-circuiting of air through outside coil or from outside coil to outdoor-air intake.
 6. Inspect casing insulation for integrity, moisture content, and adhesion.
 7. Verify that clearances have been provided for servicing.
 8. Verify that controls are connected and operable.
 9. Verify that filters are installed.
 10. Clean coils and inspect for construction debris.
 11. Inspect and adjust vibration isolators.
 12. Verify bearing lubrication.
 13. Clean fans and inspect fan-wheel rotation for movement in correct direction without vibration and binding.
 14. Adjust fan belts to proper alignment and tension.
 15. Start unit.
 16. Inspect and record performance of interlocks and protective devices including response to smoke detectors by fan controls and fire alarm.
 17. Operate unit for run-in period.
 18. Calibrate controls.
 19. Adjust and inspect high-temperature limits.
 20. Inspect outdoor-air dampers for proper stroke.
 21. Verify operational sequence of controls.
 22. Measure and record the following airflows. Plot fan volumes on fan curve.
 - a. Supply-air volume.
 - b. Return-air flow.
 - c. Outdoor-air flow.
- B. After startup, change filters, verify bearing lubrication, and adjust belt tension.
- C. Remove and replace components that do not properly operate and repeat startup procedures as specified above.
- D. Prepare written report of the results of startup services.

3.5 ADJUSTING

- A. Adjust initial temperature and humidity set points.
- B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- C. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 237433

SECTION 238126 - SPLIT-SYSTEM HEAT PUMPS AND AIR-CONDITIONERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.

1.2 SUMMARY

- A. Section includes split-system air-conditioning and heat-pump units consisting of separate evaporator-fan and compressor-condenser components.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Wiring Diagrams: For power, signal, and control wiring.
- C. Samples for Initial Selection: For units with factory-applied color finishes.

1.4 INFORMATIONAL SUBMITTALS

- A. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For split-system air-conditioning and heat pump units to include in emergency, operation, and maintenance manuals.
- B. Manufacturer's startup worksheets for each unit on project.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Filters: Three set(s) for each air-handling unit.
 - 2. Fan Belts: One set(s) for each air-handling unit fan.

1.7 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASHRAE Compliance:
 - 1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
 - 2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - "Procedures," and Section 7 - "Construction and System Start-up."
- C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.
- D. All wiring shall be in accordance with the National Electrical Code (N.E.C.) and local codes as required.

1.8 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases.
- B. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Unit shall be stored and handled according to the manufacturer's recommendations.
- B. The unit controller shall be shipped separately and shall be able to withstand 105°F storage temperatures and 95% relative humidity without adverse effect.

1.10 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period:

- a. For Compressor: Five year(s) from date of Substantial Completion.
- b. For Parts: One year(s) from date of Substantial Completion.
- c. For Labor: One year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Carrier Corporation; Home Comfort and HVAC Building & Industrial Systems.
2. Friedrich Air Conditioning Company.
3. Lennox International Inc.
4. LG Electronics, HVAC Division
5. Mitsubishi Electric & Electronics USA, Inc.; HVAC Advanced Products Division.
6. McQuay International.
7. SANYO North America Corporation; SANYO Fisher Company.
8. Samsung.
9. Trane; a brand of Ingersoll Rand.
10. YORK; a Johnson Controls company.

2.2 INDOOR UNITS (5 TONS OR LESS)

A. Concealed Evaporator-Fan Components:

1. Chassis: Galvanized steel with baked enamel finish and flanged edges, removable panels for servicing, and insulation on back of panel.
2. Insulation: Faced, glass-fiber duct liner.
3. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 206/110. Furnished with expansion device, check valve and defrost thermostat accessory.
4. Electric Coil: Helical, nickel-chrome, resistance-wire heating elements; with refractory ceramic support bushings, automatic-reset thermal cutout, built-in magnetic contactors, manual-reset thermal cutout, airflow proving device, and one-time fuses in terminal box for overcurrent protection. Heater shall be designed specifically for the indoor unit and shall meet all requirements of the National Electric Code and Underwriters Laboratories and shall be so stamped.
5. Fan: Forward-curved, double-width wheel of galvanized steel; directly connected to motor.
6. Fan Motors:
 - a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Section "Common Motor Requirements for HVAC Equipment."
 - b. Multitapped, multispeed (minimum 3 speed) with internal thermal protection and permanent lubrication.
 - c. Wiring Terminations: Connect motor to chassis wiring with plug connection.

7. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
8. Filters: 1-inch thick minimum, disposable, framed with filter rack.
9. Condensate Drain Pans:
 - a. Fabricated with one percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and humidifiers, and to direct water toward drain connection.
 - 1) Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
 - 2) Depth: A minimum of 2 inches deep.
 - b. Single-wall, galvanized-steel sheet.
 - c. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.
 - d. Pan-Top Surface Coating: Asphaltic waterproofing compound.

B. Wall-Mounted, Ductless Components:

1. The indoor unit shall be factory assembled, wired and tested. Contained within the unit shall be all factory wiring and internal piping, control circuit board and fan motor. The unit, in conjunction with the wired wall-mounted, wireless wall-mounted or wireless handheld controller, shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function, and a test run switch. Indoor unit and refrigerant pipes shall be purged with dry air before shipment from the factory.
2. The cabinet shall be formed from high strength molded plastic with smooth finish, flat front panel design with access for filter. Cabinet color shall be white – Munsell 1.0Y 9.2/0.2. The unit shall be wall mounted by means of a factory supplied, pre-drilled, mounting plate.
3. The indoor unit fan shall be high performance, double inlet, forward curve, direct drive sirocco fan with a single motor. The fans shall be statically and dynamically balanced and run on a motor with permanently lubricated bearings. The indoor fan shall consist of three (3) speeds: Low, Mid, and Hi and Auto. The fan shall have a selectable Auto fan setting that will adjust the fan speed based on the difference between controller set-point and space temperature.
4. There shall be a motorized horizontal vane to automatically direct air flow in a horizontal and downward direction for uniform air distribution. The horizontal vane shall significantly decrease downward air resistance for lower sound levels, and shall close the outlet port when operation is stopped. There shall also be a set of vertical vanes to provide horizontal swing airflow movement.
5. Return air shall be filtered by means of an easily removable washable filter.
6. The evaporator coil shall be of nonferrous construction with pre-coated aluminum strake fins on copper tubing. The multi-angled heat exchanger shall have a modified fin shape that reduces air resistance for a smoother, quieter airflow. All tube joints shall be brazed

with PhosCopper or silver alloy. The coils shall be pressure tested at the factory. A condensate pan and drain shall be provided under the coil. An optional drain pan level switch (DPLS1), designed to connect to the control board, shall be provided if required, and installed on the condensate pan to prevent condensate from overflowing. A condensate mini-pump shall be provided to provide a means of condensate disposal when a gravity drain is not available.

7. The power to the indoor unit shall be supplied from the outdoor unit.
8. The control system shall consist of a minimum of two (2) microprocessors, one on each indoor and outdoor unit, interconnected by a single non-polar two-wire cable. The microprocessor located in the indoor unit shall have the capability of monitoring return air temperature and indoor coil temperature, receiving and processing commands from a wireless or wired controller, providing emergency operation and controlling the outdoor unit. The control signal between the indoor and outdoor unit shall be pulse signal 24 volts DC. Indoor units shall have the ability to control supplemental heat via connector CN152 and a 12 VDC output.
9. Remote Controllers
 - a. Wireless, wall mounted remote controller kit The Wireless, wall mounted remote controller kit shall consist of a wireless, wall mounted controller, a wireless receiver and a cable to connect the receiver to the indoor unit. The controller shall be white in color with a light-green LCD display and a backlight feature. The controller shall consist of four Function buttons below the display, and Increase/Decrease Set Temperature buttons and a Hold button to the right of the display. The controller shall have a built-in temperature sensor and a battery holder, using two AA alkaline batteries. Temperature shall be displayed in either Fahrenheit (°F), and temperature changes shall be by increments of 1°F.
 - b. Wired Remote Controller shall be approximately 5" x 5" in size and white in color with a light-green LCD display. There shall be a built-in weekly timer with up to 8 pattern settings per day. The controller shall consist of an On/Off button, Increase/Decrease Set Temperature buttons, a Cool/Auto/Fan/Dry mode selector, a Timer Menu button, a Timer On/Off button, Set Time buttons, a Fan Speed selector, a Ventilation button, a Test Run button, and a Check Mode button. The controller shall have a built-in temperature sensor. Temperature shall be displayed in either Fahrenheit (°F), and Temperature changes shall be by increments of 1°F. The controller shall have the capability of controlling up to a maximum of 16 systems, as a group with the same mode and set-point for all, at a maximum developed control cable distance of 1,500 feet (500 meters).
 - c. The control voltage from the wired controller to the indoor unit shall be 12/24 volts, DC. Field wiring shall run directly from the indoor unit to the wall mounted controller with no splices. Up to two wired controllers shall be able to be used to control one unit.

2.3 OUTDOOR UNITS (5 TONS OR LESS)

- A. Air-Cooled, Compressor-Condenser Components:

1. Casing: Heavy gauge galvanized steel, finished with baked enamel, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
2. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation device. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
 - a. Compressor Type: Scroll.
 - b. Two-speed compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.
 - c. Refrigerant Charge: R-410A.
 - d. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid subcooler. Comply with ARI 206/110.
3. Heat-Pump Components: Reversing valve and low-temperature-air cutoff thermostat.
4. Fan: Aluminum-propeller type, directly connected to motor.
5. Motor: Permanently lubricated, with integral thermal-overload protection.
6. Low Ambient: Permits cooling operation down to 0 deg F.
7. Mounting Base: Polyethylene.
8. Furnish the following accessories: condenser coil guard, 5 minute anti recycle timer, hard start kit for units with single phase power, defrost for indoor coil, and outdoor air thermostat to prevent resistant heat from energized above 45 deg F (adjustable).

2.4 OUTDOOR UNITS (FOR USE WITH DUCTLESS UNITS)

A. Air-Cooled, Compressor-Condenser Components:

1. Casing: Galvanized Steel, thermally applied fused acrylic or powder coat finish, with easily removable panels for access to all service parts. Microprocessor controls, weep holes for water drainage, mounting feet, and fan grill. Provide brass service valves, fittings, and gage ports on exterior of casing. The outdoor unit shall be completely factory assembled, piped, and wired. Each unit must be test run at the factory. Easy access shall be afforded to all serviceable parts by means of removable panel sections.
2. Compressor: The compressor shall be a DC twin-rotor rotary compressor with Variable Speed Inverter Drive Technology. The compressor shall be driven by inverter circuit to control compressor speed. The compressor speed shall dynamically vary to match the room load for significantly increasing the efficiency of the system which shall result in significant energy savings. To prevent liquid from accumulating in the compressor during the off cycle, a minimal amount of current shall be automatically, intermittently applied to the compressor motor windings to maintain sufficient heat to vaporize any refrigerant. No crankcase heater is to be used. The outdoor unit shall have an accumulator and high pressure safety switch. The compressor shall be mounted to avoid the transmission of vibration.
3. Coil: The L shaped condenser coil shall be of copper tubing with flat aluminum fins to reduce debris build up and allow maximum airflow. The coil shall be protected with an integral metal guard. Refrigerant flow from the condenser shall be controlled by means of an electronic linear expansion valve (LEV) metering device. The LEV shall be controlled by a microprocessor controlled step motor. All refrigerant lines between outdoor and indoor units shall be of annealed, refrigeration grade copper tubing, ARC Type, meeting ASTM B280 requirements, individually insulated in twin-tube, flexible,

closed-cell, CFC-free (ozone depletion potential of zero), elastomeric material for the insulation of refrigerant pipes and tubes with thermal conductivity equal to or better than 0.27 BTU-inch/hour per Sq Ft / °F, a water vapor transmission equal to or better than 0.08 Perm-inch and superior fire ratings such that insulation will not contribute significantly to fire and up to 1" thick insulation shall have a - Flame-Spread Index of less than 25 and a Smoke-development Index of less than 50 as tested by ASTM E 84 and CAN / ULC S-102.

4. Fan: shall be furnished with a single DC fan motor. The fan blade(s) shall be of aerodynamic design for quiet operation, and the fan motor bearings shall be permanently lubricated. The outdoor unit shall have horizontal discharge airflow. The fan shall be mounted in front of the coil, pulling air across it from the rear and dispelling it through the front. The fan shall be provided with a raised guard to prevent external contact with moving parts.
5. Motor: Permanently lubricated bearings, with integral thermal-overload protection.
6. Low Ambient: Permits cooling operation down to 0 deg F.
7. Heat-Pump Components: Reversing valve and low-temperature-air cutoff thermostat.

2.5 ACCESSORIES

- A. Control equipment and sequence of operation are specified in Section "Instrumentation and Control for HVAC" and Section "Sequence and Operations for HVAC Controls."
- B. Thermostat: Wireless infrared functioning to remotely control compressor and evaporator fan, with the following features:
 1. Compressor time delay.
 2. 24-hour time control of system stop and start.
 3. Liquid-crystal display indicating temperature, set-point temperature, time setting, operating mode, and fan speed.
 4. Fan-speed selection including auto setting.
- C. Automatic-reset timer to prevent rapid cycling of compressor.
- D. Drain Hose: For condensate.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install unit's level and plumb.
- B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.
- C. Equipment Mounting:
 1. Install ground-mounted, compressor-condenser components on cast-in-place concrete equipment base(s).

2. Comply with requirements for vibration isolation devices specified in Section "Vibration Controls for HVAC."

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
 1. Piping Connections: Comply with piping requirements specified in other sections.
- B. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.
- C. Duct Connections: Duct installation requirements are specified in Section "Metal Ducts." Drawings indicate the general arrangement of ducts. Connect supply and return ducts to split-system air-conditioning units with flexible duct connectors. Flexible duct connectors are specified in Section "Air Duct Accessories."
- D. Electrical: Comply with all applicable sections regarding electrical and grounding requirements.

3.3 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Remove and replace malfunctioning units and retest as specified above.
- C. Prepare test and inspection reports.

3.4 STARTUP SERVICE

- A. Perform startup service.
 1. Complete installation and startup checks according to manufacturer's written instructions.
 2. Furnish startup worksheet with close out documents.
- B. Perform the following commissioning for all units:
 1. Level unit on support structure.
 2. Inspect for visible damage to unit casing.
 3. Inspect for visible damage to compressor, air-cooled condenser coil, and fans.
 4. Verify that clearances have been provided for servicing.
 5. Check that labels are clearly visible.

6. Verify that controls are connected and operable.
7. Remove shipping bolts, blocks, and tie-down straps.
8. Verify that filters are installed.
9. Adjust vibration isolators.
10. Check acoustic insulation.
11. Lubricate bearings on fan.
12. Check fan-wheel rotation for correct direction without vibration and binding.
13. Adjust fan belts to proper alignment and tension.
14. Start unit according to manufacturer's written instructions.
15. Perform starting of refrigeration in summer only.
16. Complete startup sheets and attach copy with Contractor's startup report.
17. Check and record performance of interlocks and protection devices; verify sequences.
18. Operate unit for an initial period as recommended or required by manufacturer.
19. Calibrate thermostats.
20. Check internal isolators.
21. Check controls for correct sequencing of heating, refrigeration, and normal and emergency shutdown.
22. Simulate maximum cooling demand and check the following:
23. Compressor refrigerant suction and hot-gas pressures.
24. Short circuiting air through condenser or from condenser to outside-air intake.
25. After starting and performance testing, install clean filters, vacuum heat exchanger and cooling and condenser coils, lubricate bearings and adjust belt tension.

3.5 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain units.
 1. Train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventive maintenance.
 2. Review data in the maintenance manuals.
 3. Schedule training with Owner, through Architect, with at least 7 days' advance

END OF SECTION 238126

SECTION 260500

COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 GENERAL

- A. Work covered by this Specification to include furnishing of labor, materials, and equipment required for installation, testing and putting into proper operation complete Electrical systems as shown on the Drawings and as hereinafter specified. The Contractor shall include cutting, trenching and backfilling, etc., necessary for the complete installation.
 - 1. Work shall include power distribution, controls, lighting systems, instrumentation and metering, wiring and telephone service (where required).
- B. Provide all materials, equipment, labor and services to complete the installation, wiring, testing and commissioning of the complete and functioning electrical systems, including but not limited to the scope of work specified in this section.
- C. Notify the Engineer of any conflicts between Codes, Specification and Drawings, plan and riser. The maximum condition is to govern, and the selection shall be based on whichever indicates the greater cost.

1.2 SCOPE

- A. The Contractor's scope of work encompasses a comprehensive list of tasks, including but not limited to supplying, delivering, unloading, assembling, initiating, testing, commissioning, and ultimately transferring the electrical services installation described in detail in the specifications and indicated on the Drawings, all in adherence to the contract documents.
- B. The Contractor shall thoroughly review and comprehend the specification and the extent of the work. Additionally, they are tasked with providing all the necessary conduit, wiring, power supplies, accessories, and supplementary components required to ensure the safe and proper operation of the power, control and instrumentation systems.
- C. The Contractor is responsible for the following:
 - 1. To visit the site and become familiar with the scope of work.

2. To prepare shop drawings and obtain approvals from relevant authorities before commencing work.
3. To secure approvals for materials and workmanship during the execution and upon completion of the project.
4. To incorporate all costs and charges associated with local authorities (fees, permits and testing), as well as those related to permanent power supply connections. The Owner will be responsible for covering the power connection charges.
5. Collaborate with other trades to ensure the coordinated placement of fixtures, outlets, equipment, and devices, thereby preventing any conflicts.
6. Furnish all anchor bolts, inserts, and supports as required to be installed by other trades as needed.

1.3 RELATED SECTIONS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Section 260519 Conductors
- C. Section 260526 Grounding and Bonding
- D. Section 260533 Raceway and Boxes
- E. Section 262213 Low Voltage Transformers
- F. Section 262413 Switchboards
- G. Section 262416 Panelboards
- H. Section 262726 Wiring Devices
- I. Section 262816 Safety Switches
- J. Section 26 29 23 Variable Frequency Drives
- K. Section 263213 Generator
- L. Section 263623 Automatic Transfer Switches
- M. Section 265000 Lighting

1.4 REFERENCES

- A. The equipment in this specification is designed and manufactured according to latest revision of the following standards (unless otherwise noted).
 - 1. NPFA 101 - Life Safety Code
 - 2. American Society for Testing and Materials (ASTM)
 - 3. Insulated Cable Engineers Association (ICEA)
 - 4. Institute of Electrical and Electronics Engineers (IEEE)
 - 5. International Society of Automation (ISA)
 - 6. National Electrical Manufacturers Association (NEMA)
 - 7. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC)
 - 8. National Standards Institute (ANSI)
 - 9. Underwriters Laboratories (UL)

1.5 DEFINITIONS

- A. Unless specifically defined within the Contract Documents, the words or acronyms contained within this specification shall be as defined within, or by the references listed within this specification, the Contract Documents, or, if not listed by either, by common industry practice.

1.6 SUBMITTALS

- A. Manufacturer shall provide copies of following documents to owner for review and evaluation in accordance with general requirements of Division 1 and Division 26:
- B. Submit sufficient information to determine compliance with the Contract Documents. Identify submittal data with the specific equipment tags and/or service descriptions to which they pertain. Submittal data shall be clearly marked to identify the specific model numbers, options, and features of equipment and work proposed.
- C. Deviations from the Contract Documents shall be indicated within the submittal. Each deviation shall reference the corresponding drawing or specification number, show the Contract Document requirement text and/or illustration, and shall be accompanied by a detailed written justification for the deviation.

- D. Contractor's submittal shall include a list of manufacturers of principal items of equipment and material including conduit tubing and fittings, power conductors, wireway, outlet boxes and terminals, pull boxes and junction boxes, manholes and handholes, control cable, receptacles, surge suppressors, switches, etc. Full information shall be furnished on products of manufacturers not named in the Contract Documents.
- E. Shop drawings shall be submitted giving performance data, physical size, wiring diagrams, materials, etc., for control centers, lighting fixtures, motor controllers, panelboards, conduit and duct, and cable and wire.
- F. The requirements of each electrical system shall be identified by the Contractor before submission of shop drawings, and all necessary accessory parts required between items of electrical equipment shall be identified in sufficient detail to prove that the total equipment furnished and installed will operate as specified and shown on the Drawings.
- G. Shop drawings and samples shall be thoroughly checked and coordinated by the Contractor for details and fulfillment of Contract requirements prior to submittal. Approval of any item does not relieve Contractor of responsibility for coordinating dimensions and work required by other trades.

1.7 PROJECT RECORD DRAWINGS

- A. Maintain an up-to-date set of Contract documents. Note any and all revisions and deviations that are made during the course of the project.
- B. Provide final typical outline drawing

1.8 OPERATION AND MAINTENANCE DATA

- A. Manufacturer shall provide copies of installation, operation and maintenance procedures to owner in accordance with general requirements of Division 1 and Division 26.
- B. Submit operation and maintenance data based on factory and field testing, operation and maintenance of specified products.
- C. Include the following information in the Operation and Maintenance manuals:
 - 1. Names and address of local suppliers for the items included.
 - 2. Details of design elements, construction features, component function and maintenance requirements, to permit effective startup, operation, maintenance, repair, modification, extension and expansion of any portion or feature of the installation.

3. Technical data, product data, supplemented by bulletins, component illustrations, exploded views, technical descriptions of items and parts lists. Advertising or sales literature is not acceptable.
4. Review information provided in the maintenance instructions and manuals with the Owners' operating personnel to ensure a complete understanding of the electrical equipment and systems and their operation.

1.9 QUALITY ASSURANCE

- A. All work performed and all materials used shall be in accordance with the National Electrical Code, and with applicable local regulations and ordinances. Equipment, assemblies and materials shall be listed and labeled by Underwriter's Laboratories or by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect, and handle products in accordance with the manufacturer recommendations.
- B. All materials shall be unloaded and stored in a manner to avoid physical damage or detrimental effects of exposure to weather.

1.11 WARRANTY

- A. Contractor shall warranty all work executed under this section will be free from defects of workmanship and materials for a period of one (1) year from date of final acceptance of this work.
- B. The Contractor responsible for repairing and replacing, at their own expense any defective work, and all other work damaged thereby, which becomes defective during warranty period.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Submittals: The Contractor is responsible for organizing and structuring the material submittals, along with related drawings, for approval by the Engineer. These submittals should include the necessary details as requested by the Engineer.

B. Substitutions: The Contractor is required to select items and materials either from the approved list of suppliers/manufacturers or provide an alternative option for approval. However, this alternative choice is limited to a single selection, and if it's rejected, the Contractor must revert to using the approved suppliers/manufacturers list. Contractor shall not use substitutions without written approval from the Engineer.

1. Substitutions shall meet the following minimum requirements:

- a. Capacities indicated are the absolute minimum
- b. Compatibility with other materials and equipment
- c. Interchangeability
- d. Noise levels
- e. Physical size limitations
- f. Same manufacturer where practicable
- g. Structural requirements

C. Materials must meet the following criteria:

1. Be designed, manufactured, and tested in compliance with the latest versions of all relevant UL and other applicable industry standards.
2. Be certified by UL, ANSI, NEMA or be acceptable to the relevant authorities, including special inspection if required.
3. All electrical equipment must be designed to operate in a 122°F ambient temperature with 100% relative humidity.
4. If multiple items of the same type are required, they must all be of the same type and manufacturer.
5. Products from specified manufacturers are acceptable only when they comply with or are modified as necessary to meet the contract document requirements.
6. Items of equipment or materials not explicitly defined herein should conform to the general standard of quality established in this document.

2.2 FINISHES

A. Shop finish metal enclosure surfaces by application of rust resistant primer inside and outside, and at least two coats of finish enamel.

- B. Clean and touch up surfaces of shop-painted equipment scratched during shipment or installation, to match original paint.
- C. Clean and prime exposed non-galvanized hangers, racks and fasteners to prevent rusting.

PART 3 - EXECUTION

3.1 GENERAL

- A. In addition to the requirements specified herein, execution shall be in accordance with the requirements of Specification Division 26 and Drawings.
- B. Inspect preceding work to ensure satisfactory completion prior to electrical work.
- C. Coordinate work with local power company and Owner to minimize delays in operation of new facilities.
- D. Wiring layouts or schematics are not intended to show exact location of raceways, outlets, etc. Contractor shall refer to building plans and details for dimensions and shall fit his work to conform to details of building construction. The right is reserved to shift any switch, receptacle, ceiling or other outlet a maximum of 10' from its location as shown on Drawings before it is permanently installed without incurring additional expense.

3.2 INSTALLATION

- A. Contractor shall furnish all labor and furnish, install, connect, test and adjust all equipment and materials to form a complete operating installation, including wiring hangers, supports for equipment, cables, conduits, cable tray, cable trench, pull boxes anchors and inserts, identification plates, signs, and tags for equipment, conduits, wiring and wiring labels.
- B. The contractor must provide the following:
 - 1. Circuits originating from branch distribution panels.
 - 2. Lighting and its control.
 - 3. Motors, heaters and associated control equipment including sequenced operation of systems where applicable.
 - 4. Coordinate numbers and label all field wiring between equipment of the various electrical equipment suppliers.

5. All wiring for testing and trials, for all required corrections, changes, additions, completions and adjustments until final acceptance of the work.

C. The electrical work shall be installed in such a manner and at such times as will require a minimum of cutting and patching of the building structure.

D. Any damage to work already in place as a result of electrical work shall be repaired and made good at no expense to the Owner.

3.3 WORKMANSHIP

A. Install conduits and pipes parallel and perpendicular to the building planes and concealed in chases, behind furring or above ceiling, except in unfinished areas. Install all exposed systems neatly and grouped together, to present a neat appearance.

B. Install all equipment and apparatus requiring maintenance, adjustment or replacement with sufficient clearance for servicing.

C. Include in the work all requirements of the manufacturer and as shown on the shop drawings.

D. Replace any work unsatisfactory to the Engineer/Owner without extra cost.

3.4 IDENTIFICATION

A. Have the manufacturers nameplate affixed to each item of all equipment showing the size, name of equipment, serial number and all information usually provided, including voltage, frequency, # of phases, horsepower, etc., and the name of the manufacturer and his address. Ensure that all stamped, etched and engraved lettering on plates is perfectly legible. Ensure that nameplates are not painted over.

B. Identify all major items of equipment including control panels, panelboards, switchboards, transformers, VFD's, enclosed motor starters, enclosed circuit breakers, disconnect switches and automatic transfer switches with wording approved by Engineer.

C. Each panel shall have each circuit identified. Panels without branch circuit nameplates shall have typewritten directories mounted on the panel door.

D. See Section 26 05 53 Identification for Electrical Systems for additional requirements.

3.5 TESTING AND ACCEPTANCE:

A. Prior to acceptance by the Owner, all control systems shall function as required, and all motors shall be connected to protective devices and control devices associated with a

machine or a group of machines to produce the correct operating, timing and sequencing necessary for the proper functioning of the mechanical equipment.

- B. The Contractor is responsible for ensuring that all systems are prepared for operation and for having an electrician on hand to operate them in accordance with the Engineer's representative(s) supervision. The Electrician should also be available to assist in the removal of panel fronts and other necessary actions to facilitate inspections as needed.

3.6 FIELD QUALITY CONTROL

- A. Carefully check each piece of apparatus for completeness of connections, accessories, wiring and controls and place in operation, test and adjust.
- B. Correct defects; repeat tests until no defects are disclosed; leave equipment clean and ready for use.
- C. The Contractor is responsible for the following:
 - 1. Power distribution system testing including proper rotation, phasing, voltage, grounding and load balancing.
 - 2. Furnish manufacturer's certificate or letter confirming that entire installation as it pertains to each system has been installed to manufacturer's instructions.
 - 3. Insulation resistance testing.
 - a. Megger circuits, feeders and equipment up to 350 V with a 500 V instrument.
 - b. Megger 350-600 V circuits, feeders and equipment with a 1000 V instrument.
 - 4. Check resistance to ground before energizing.
 - 5. Any tests and commissioning work identified in the individual sections of Division 26.
 - 6. Providing instruments, meters, equipment and personnel required to conduct tests.
 - 7. Submit test results for Engineer's review.
- D. Contractor shall not energize the electrical equipment covered in this Division without permission from the Engineer.

3.7 AS-BUILT DRAWINGS:

- A. Submit one blueline print of the Drawings marked to show as-built locations including all changes, revisions and substitutions to the electrical work.

3.8 TEMPORARY SERVICES

- A. Temporary electrical service for electrical power used during construction shall be provided and paid for by the Contractor.
- B. Do not use any of the permanent electrical systems during construction, unless specific written approval is obtained from the Engineer or unless allowed elsewhere in the contract documents.

END OF SECTION

SECTION 260519

CONDUCTORS

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide labor, material, equipment, related services, and supervision required, including, but not limited to installation, connections and testing of all wire and cable components including splices, terminations, connectors and accessories as required for the complete performance of the work, as shown on the Drawings, as specified herein.
- B. RELATED SECTIONS
 - 1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
 - 2. Division 26 Section "Common Work Results for Electrical".

1.2 REFERENCES

- A. The equipment in this specification is designed and manufactured according to latest revision of the following standards (unless otherwise noted).
 - 1. American Society for Testing and Materials (ASTM)
 - a. ASTM B3 – Standard Specification for Soft or Annealed Copper Wire
 - b. ASTM B8 – Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
 - c. ASTM B496 – Standard Specification for Compact Round Concentric-Lay-Stranded Copper Conductors
 - 2. Insulated Cable Engineers Association (ICEA)
 - 3. Institute of Electrical and Electronics Engineers (IEEE)
 - 4. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC)
 - 5. NEMA WC 70/ICEA S95-658
 - 6. Underwriters Laboratories (UL)

- a. UL 83 – Standard for Safety Thermoplastic-Insulated Wires and Cables
- b. UL 1518 – Reference Standard for Electrical Wires, Cables, and Flexible Cords

1.3 SUBMITTALS

- A. Submit sufficient information to determine compliance with the Contract Documents. Identify submittal data with the specific equipment tags and/or service descriptions to which they pertain. Submittal data shall be clearly marked to identify the specific model numbers, options, and features of equipment and work proposed.
- B. Deviations from the Contract Documents shall be indicated within the submittal. Each deviation shall reference the corresponding drawing or specification number, show the Contract Document requirement text and/or illustration, and shall be accompanied by a detailed written justification for the deviation.
- C. Manufacturer shall provide copies of following documents to owner for review and evaluation in accordance with general requirements of Division 1 and Division 26.
 - 1. Product data on specified product documenting the following
 - a. Wire and cable.
 - b. Wire and cable accessories.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect, and handle wire and cable in accordance with the manufacturer recommendations.
- B. All materials shall be unloaded and stored in its original packaging in a manner to avoid physical damage or detrimental effects of exposure to weather.

1.5 WARRANTY

- A. Provide a guarantee against defective materials and workmanship in accordance with requirements of the Section 260500 of these Specifications.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

- A. Subject to being equivalent and subject to compliance with requirements, provide product by one of the following manufacturers; Alcan Products Corporation, American Insulated Wire Corp, Belden CDT Inc., Encore Wire Corporation, General Cable Technologies Corporation, Southwire Incorporated, or Republic Wire.
- B. Conductor insulation and multiconductor cables shall comply with NEMA WC 70/ICEA S95-658. Refer to Part 3 of this section for allowable types specific to this project.
- C. MC Cable (Metal-Clad):
 - 1. Provide Type MC Cables that are minimum 90 degrees C rated, with components and fittings listed for grounding, compliant with NEC Articles 250 and 330.
 - 2. Provide compatible steel fittings with integral red plastic insulated throat bushings, compliant with NEC 330.
- D. Conductors shall have current carrying capacities as per N.E.C. and with 600 volt insulation rated at 90 degrees, #12 minimum except for controls wire. Conductors shall be copper.
- E. General Application
 - 1. Provide stranded copper wire for #8 and larger conductors and #10 or smaller circuit terminating at motors. Provide solid copper conductors for #10 or smaller circuits not terminating at motors.
 - 2. Service entrance conductors:
 - a. Type USE-2, XHHW-2 insulation for service entrance conductors routed from exterior source to exterior termination location.
 - b. Type XHHW-2 insulation for services entrance conductors routed from exterior source to interior termination location.
 - 3. Above grade wire for exterior work within conduit:
 - a. THHN/THWN, or XHHW-2 insulation.
 - 4. Below grade wires including within slab on grade within conduit:
 - a. Provide XHHW-2 insulation for #8 and larger conductors and THHN/THWN or XHHW-2 insulation for #10 or smaller circuits.

5. Multi-conductor shielded variable frequency drive conductors:
 - a. Soft annealed flexible stranded copper conductors.
 - b. 1kV XLPO or XLPE insulation (to resist the potential reflected voltages experienced in 600VAC VFD applications).
 - c. Metallic shielded providing 100% shield coverage.
 - d. AmerCable, Belden VFD cable or equal.
6. Grounding conductors
 - a. Bare grounding conductor sized as shown on the Drawings. Conductors #6 and smaller may be solid. Conductors #4 and larger shall be stranded.
 - b. Equipment grounding conductor stranded copper with green type THHN/THWN insulation.
7. Control circuits and conductors
 - a. Conductors shall be #12 or #14, seven strand as shown on the Drawings.
8. Instrument cable
 - a. 2 # 18 AWG, twisted shielded pair, UL Instrument Cable, XLPE conductor insulation, PVC outer jacket unless noted otherwise.
9. Ethernet cable
 - a. Provide Cat6a shielded twisted pair #23 AWG suited for outdoor use routed through conduits.
10. Fiber optic cable
 - a. Coordinate with SCADA integrator.

2.2 CONNECTIONS AND SPLICES

- A. Subject to being equivalent and subject to compliance with requirements, provide products by one of the following manufacturers; AFC Cable Systems, Inc., Arrow-Hart Div, Crouse-Hinds, Gardner Bender, Hubbell Power Systems, Inc., Ideal Industries, Inc., Ilsco; a branch of Bardes Corporation, NSi Industries LLC., O-Z/Gedney, 3M; Tyco Electronics, Square D, or Thomas and Betts.

- B. Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated. Use connectors with temperature ratings equal to or greater than those of the wires upon which used.
- C. Make joints and terminations with splice and termination kits suited to the installation environment in accordance with kit manufacturer's instructions.
- D. Motor Connections
 - 1. Unshielded conductor cables shall be made with insulated motor lead pigtail splice kits 3M 5300 Series 1kV with mechanical lugs as required. Install lug covers and mastic sealing tape per manufacturer's instructions.
 - 2. The braided shields and internal grounding conductors of shielded cables shall be grounded at both ends with a termination kit provided by the manufacturer.

PART 3 - EXECUTION

3.1 CABLE INSTALLATION

- A. Refer to Cable Schedule on the Drawings.
- B. Conductor installation shall be in accordance with manufacturer's recommendations.
- C. Do not exceed cable manufacturer's recommendations for maximum pulling tensions and minimum bending radii.
- D. Conceal cables in finished walls, ceilings and floors unless otherwise indicated.
- E. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- F. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- G. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- H. Conductors within switchboards, panelboards, terminal cabinets, starters, control centers, etc., shall be neatly formed and trained to run parallel to or at right angles to the device. Conductors shall be bundled together and laced using nylon tie straps.
- I. Control raceway and wiring shall be installed and fully connected to make system operational.

- J. All interconnecting wiring shall be installed in approved conduit or cable trays and connected as shown on the Drawings. Unless otherwise shown or specified, all wiring shall be run in raceways see Section 260533.

3.2 CONNECTIONS:

- A. Conductor splices and connections shall be made with approved solderless lugs and mechanical connections to ensure positive electrically and mechanically strong joints. Use of connectors without internal spiral spring (wire nuts) is not acceptable.
- B. Where bolted connectors are used for makeup of cables or for termination, they must be exact size to suit cable being used. Trimming, shimming or cutting of conductor strands are not permitted. Where branch circuit conduits are jointed or spliced using crimp-on or twist-on connectors, wires must first be twisted together full length and then connector installed.
- C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- D. Install splices or terminations as continuous operation in accessible locations under clean, dry conditions.

3.3 CONDUCTOR SIZING

- A. Conductor sizes indicated in Division 26 documents are based on 75 degree copper unless specifically indicated otherwise on single-line diagram on drawings.
- B. Power cable shall be minimum #12 AWG conductor, unless specifically indicated otherwise on Drawings.
- C. Control cable shall be minimum #14 AWG single or multiple conductor cable with 600V insulation.
- D. Unless specifically indicated otherwise on Drawings, provide grounded (“neutral”) conductors that are at least parity-sized with corresponding phase/line conductors for all applications.

3.4 CIRCUIT IDENTIFICATION

- A. Identify power, instrumentation, and control conductor circuits at each termination, and in accessible locations such as manholes, handholes, panels, switchboards, motor control centers, pull boxes, and terminal boxes.
- B. Identify using circuit schedule designations as shown on the Drawings.

C. Method:

1. Conductors 3 AWG and Smaller: Identify with sleeves or heat bond markers.
2. Cables and Conductors 2 AWG and Larger:
 - a. Identify with marker plates or tie-on cable marker tags.

END OF SECTION

SECTION 260526

GROUNDING AND BONDING

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide labor, material, equipment, related services, and supervision required, including, but not limited to installation, connections and testing of all grounding and bonding systems and accessories as required for the complete performance of the work, as shown on the Drawings, as specified herein.
- B. RELATED SECTIONS
 - 1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
 - 2. Division 26 Section "Common Work Results for Electrical".

1.2 REFERENCES

- A. The equipment in this specification is designed and manufactured according to latest revision of the following standards (unless otherwise noted).
 - 1. Institute of Electrical and Electronics Engineers (IEEE): C2, National Electrical Safety Code (NESC).
 - 2. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC)
 - 3. Underwriters Laboratories (UL)

1.3 SUBMITTALS

- A. Submit sufficient information to determine compliance with the Contract Documents. Identify submittal data with the specific equipment tags and/or service descriptions to which they pertain. Submittal data shall be clearly marked to identify the specific model numbers, options, and features of equipment and work proposed.
- B. Deviations from the Contract Documents shall be indicated within the submittal. Each deviation shall reference the corresponding drawing or specification number, show the

Contract Document requirement text and/or illustration, and shall be accompanied by a detailed written justification for the deviation.

- C. Manufacturer shall provide copies of following documents to owner for review and evaluation in accordance with general requirements of Division 1 and Division 26.
 - 1. Product data on specified product documenting the following
 - a. Wire and cable.
 - b. Ground rods
 - c. Test wells
- D. Provide a guarantee against defective materials and workmanship in accordance with requirements of the Section 260500 of these Specifications.

PART 2 - PRODUCTS

2.1 GROUNDING CONDUCTORS

- A. All ground conductors shall be at least 12 AWG soft drawn copper cable or bar, bare or green-insulated in accordance with the National Electrical Code.
- B. Main service conduits, entering switchgear, panels, control center, switches, etc., shall be provided with insulating bushings with ground lug and connected to building ground system.
- C. Bonding jumpers shall be copper tape, braided conductors, terminated with copper ferrules sized in accordance with the National Electrical Code table on sizes of equipment grounding electrode conductors.
- D. All flexible conduits making final connections to motors, lights, vibrating equipment, etc., shall contain a green copper bonding conductor which shall extend from outlet box where flexible conduit originates or from nearest box in line to the equipment served.

2.2 GROUNDING RODS

- A. Ground rods shall be a minimum of 5/8" in diameter by 10' long, with a copper jacket bonded to a steel core. Ground rods shall be UL listed and REA approved and shall conform to ANSI C33.8.
- B. Where longer electrodes are necessary to reduce the ground resistance, Contractor shall provide sectional rods, connectors, drive heads, etc.

- C. Connections between grounding conductors and grounding rods shall be mechanical if above ground, thermal if underground.

2.3 GROUNDING CONNECTIONS

- A. Subject to being equivalent and subject to compliance with requirements, provide product by one of the following manufacturers; Raco, O-Z/Gedney, Ercon, Square D, Brundy, or Thomas and Betts.
- B. All grounding connections of copper to copper and copper to steel conductors of #8 and larger sized conductors shall be CADWELD exothermic welded connections. Conductors spliced with a CADWELD exothermic welded connection shall be considered as a continuous conductor, as stated in the notes accompanying NEC 250-50, 250-64, 250-68, 250-70 and IEEE 80.
- C. All grounding connections to equipment shall use bolted lugs. When the conductor is #8 and larger, the lug shall be joined to the conductor by the CADWELD process, otherwise use listed compression lugs which meet IEEE 837.
- D. Connections to equipment shall be by bolted compression type lugs (except for motors). When the conductor is #6 and larger, the lug shall be joined to the conductor by an exothermic weld connection.
- E. Each cast pull box or junction box shall have a ground lug, connected to largest ground conductor to enter box.

2.4 TEST WELLS

- A. Test wells and covers for non-traffic areas shall be molded high density polyethylene. Test wells for traffic areas shall be precast concrete construction rated for traffic duty with concrete or cast iron covers.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. All equipment, building steel and main service must be effectively and permanently grounded with a cross section as required by the NEC and of capacity sufficient to ensure effectiveness of the ground connections for fault current.
- B. Ground conductors must be as short and straight as possible and protected from mechanical injury, if practical, without splice or joint. Where practicable, ground conductors shall be routed to avoid bends exceeding 90 degrees or with a radius of less than 8”.

- C. Raceways, boxes, outlets, cabinets, enclosures etc., shall be bonded together to form a continuous metallic grounding circuit in accordance with NEC.
- D. All powered equipment, including lighting fixtures and receptacles, shall be grounded by a copper ground conductor in addition to the conduit connection.
- E. Each receptacle and switch device shall be furnished with a grounding screw connected to the metallic device frame. Bond equipment grounding conductor to each outlet box. For isolated ground receptacles, bond equipment grounding conductor to box, and bond isolated ground conductor to device grounding screw.

3.2 ACCEPTANCE

- A. Engineer or their representative shall observe the underground grounding system prior to burial.
- B. Contractor shall measure the resistance between the main ground bonding jumper to true earth ground using the Fall of Potential method as described by ANSI/IEEE Standard 81 (“Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of an Earth System”). If the measured value is greater than five ohms, additional grounding electrodes shall be installed as needed,

END OF SECTION

SECTION 260533

RACEWAY AND BOXES

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide labor, material, equipment, related services, and supervision required, including, but not limited to installation of boxes and routing all conduits including fittings, couplings, connectors, bushings, raceway hardware, conduit clamps and supports as required for the complete performance of the work, as shown on the Drawings, as specified herein.
- B. RELATED SECTIONS
 - 1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
 - 2. Division 26 Section "Common Work Results for Electrical".

1.2 REFERENCES

- A. The equipment in this specification is designed and manufactured according to latest revision of the following standards (unless otherwise noted).
 - 1. ANSI 77 – Specifications for Underground Enclosure Integrity
 - 2. ASTM International (ASTM).
 - 3. National Electrical Contractor's Association, Inc. (NECA)
 - 4. National Electrical Manufacturers Association (NEMA)
 - 5. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC)
 - 6. Underwriters Laboratories (UL)

1.3 SUBMITTALS

- A. Submit sufficient information to determine compliance with the Contract Documents. Identify submittal data with the specific equipment tags and/or service descriptions to

which they pertain. Submittal data shall be clearly marked to identify the specific model numbers, options, and features of equipment and work proposed.

- B. Deviations from the Contract Documents shall be indicated within the submittal. Each deviation shall reference the corresponding drawing or specification number, show the Contract Document requirement text and/or illustration, and shall be accompanied by a detailed written justification for the deviation.
- C. Manufacturer shall provide copies of following documents to owner for review and evaluation in accordance with general requirements of Division 1 and Division 26.
 - 1. Product data on and catalog sheets for all raceway and box components
 - a. Conduit
 - b. Wireways
 - c. Junction & Pull Boxes
 - d. Precast Manholes and Handholes
- D. Provide a guarantee against defective materials and workmanship in accordance with requirements of the Section 260500 of these Specifications.

PART 2 - PRODUCTS

2.1 CONDUIT AND TUBING

- A. Subject to being equivalent and subject to compliance with requirements, provide product by one of the following manufacturers; Allied, Atkore, Calbond, Cantex, Carlon, Centaur, Certinteed, Hubbell, Ocal, Plasti-Bond, Robroy, Southwire or Wheatland
- B. Galvanized Rigid Conduit (GRC):
 - 1. Meet requirements of ANSI C80.1 and UL 6.
 - 2. Hot-dip galvanized inside and out to provide galvanic corrosion protection. Also coated with a compatible organic layer to protect against white rust.
- C. Rigid Aluminum Conduit (RAC):
 - 1. Meet requirements of ANSI C80.5 and UL 6651.
 - 2. Material: Type 6063 alloy in temper designation T-1.

D. PVC Schedule 40 Rigid Conduit:

1. Meet requirements of NEMA TC 2 and UL 651.
2. UL listed for concrete encasement, underground direct burial, concealed or direct sunlight exposure, and 90 degrees C insulated conductors.

E. PVC-Coated Rigid Galvanized Steel Conduit:

1. Meet requirements of NEMA RN 1, ETL PVC-001 ANSI C80.1 and UL 6.
2. Material:
 - a. Exterior Finish: PVC coating, 40-mil nominal thickness.
 - b. Interior finish: Urethane coating, 2-mil nominal thickness.
 - c. Threads: Hot-dipped galvanized and factory coated with urethane.
 - d. Mounting hardware, which includes nuts, bolts, and anchors, shall be PVC coated or stainless steel.

F. Flexible Metal, Liquid-Tight Conduit:

1. Meet the requirements of UL 360.
2. Material: Galvanized steel with flexible PVC jacket.
 - a. UL 360 listed for -55 to 80 degrees C insulated conductors.

G. Flexible, Nonmetallic, Liquid-Tight Conduit:

1. Meet the requirements of ANSI 79 and UL 1660:
2. Material: PVC core with fused flexible PVC jacket.
 - a. Suitable for use at conduit temperatures of 80°C dry, 60°C wet

2.2 FITTINGS AND BUSHINGS

- A. Subject to being equivalent and subject to compliance with requirements, provide product by one of the following manufacturers; Appleton, Atkore, Calbond, Cantex, Carlon, Centaur, Certainteed, Crouse-Hinds, Hubbell, Killark, Meyers, O-Z/Gedney; a brand of the EGS Electrical Group, Ocal, Plasti-Bond, Racco, Robroy, Southwire, Thomas & Betts, Topaz, or Wheatland.

B. Galvanized Rigid Conduit

1. General:
 - a. Meet requirements of UL 514B, UL 467.
 - b. Type: Threaded, galvanized.
2. Bushing:
 - a. UL listed E-14814, and NEMA FB-1.
 - b. Materials: Zinc electroplated malleable iron with integral insulated throat,
3. Grounding Bushing:
 - a. UL listed E-6581, and NEMA FB-1.
 - b. Materials: Zinc electroplated malleable iron with integral insulated throat,
4. Conduit Hub:
 - a. UL listed E-11853, and NEMA FB-1, -4, and -12.
 - b. Materials: Zinc electroplated ductile iron with neoprene gasket and bonding screw.
 - c. UL listed for use in wet locations.
5. Conduit Bodies:
 - a. Sized as required by NEC.
 - b. UL listed E-2527, and NEMA FB-1.
 - c. Materials: Zinc electroplated malleable iron bodies and covers, stainless steel cover screws with neoprene gaskets
6. Couplings: As supplied by conduit manufacturer.
7. Unions:
 - a. Three-piece coupling
 - b. UL Listed: E-11853, and E-14817
 - c. Materials: Zinc electroplated malleable iron.
8. Conduit Sealing Fitting:

- a. UL Standard 886, UL listed E1044, and E-34997 for use with Kwiko sealing compound.
- b. Materials: Zinc electroplated malleable iron.

C. Rigid Aluminum Conduit

- 1. General:
 - a. Meet requirements of UL 514B.
 - b. Type: Threaded, copper-free.
- 2. Insulated Bushing:
 - a. UL listed E-11853, and NEMA FB-1.
 - b. Materials: Cast aluminum, with integral insulated throat
- 3. Grounding Bushing:
 - a. UL listed E-24264, and NEMA FB-1.
 - b. Materials: Cast aluminum with integral insulated throat with tin plated copper saddle.
- 4. Conduit Hub:
 - a. UL Listed: E-24264, E-11853, and NEMA FB-1.
 - b. Materials: Cast aluminum, with insulated throat and stainless steel ground screw.
 - c. UL listed for use in wet locations.
- 5. Conduit Bodies:
 - a. UL Listed: E-2527, and NEMA FB-1.
 - b. Materials: Copper free aluminum, neoprene gasket and stainless steel screws.
- 6. Couplings: As supplied by conduit manufacturer.
- 7. Conduit Sealing Fitting, Drain Seal:
 - a. UL Standard 886, UL listed E1044, and E-34997 for use with Kwiko sealing compound.

- b. Materials: Copper free aluminum
- 8. Drain/Breather Fitting:
 - a. UL Listed: E-34997.
 - b. Materials: Copper free aluminum
- 9. Expansion Fitting:
 - a. UL Listed for use in wet locations
 - b. Materials: Copper free aluminum
- D. PVC Schedule 40 Rigid Conduit and Tubing:
 - 1. Meet requirements of NEMA TC 3.
 - 2. Type: PVC, slip-on.
- E. PVC-Coated Rigid Galvanized Steel Conduit:
 - 1. Meet requirements of UL 514B.
 - 2. Fittings: Rigid galvanized steel type, PVC coated by conduit manufacturer.
 - 3. Conduit Bodies: Cast metal hot-dipped galvanized or urethane finish. Cover shall be of same material as conduit body. PVC coated by conduit manufacturer.
 - 4. Finish: 40-mil PVC exterior, 2-mil urethane interior.
 - 5. PVC-coated conduit hangers, attachments, and accessories.
 - 6. Expansion fitting:
 - a. UL Listed
 - b. Materials: Steel with PVC coating
 - c. Finish: 40-mil PVC exterior, 2-mil urethane interior.
 - d. Internal grounding system
- F. Flexible Metal, Liquid-Tight Conduit:
 - 1. UL Listed E-23018, and NEMA FB-1.
 - 2. Metal insulated throat connectors with integral nylon or plastic bushing

3. Insulated throat and sealing O-rings.
 4. Materials: malleable iron with Zinc Chromate finish
- G. Flexible, Nonmetallic, Liquid-Tight Conduit:
1. Meet requirements of UL 514B.
 2. Tapered thread hub and furnished Neoprene sealing O-ring provide a liquid-tight, dust-tight seal to a box or enclosure
- H. Flexible Coupling, Hazardous Locations:
1. Approved for use in atmosphere involved.
 2. Meet requirements of UL 668, UL Listed E-34997
 3. Rating: Watertight and UL listed for use in Class I, Division 1 and 2 areas.
 4. Materials: Outer bronze braid, inner brass core with insulating liner.
 5. Electrical conductivity equal to rigid conduit on a similar length basis. No bonding jumper required.
- I. Watertight Entrance Seal Device:
1. New Construction:
 - a. Bodies and pressure clamps are high strength malleable or ductile iron coated with a high organic zinc sacrificial conductive epoxy coating.
 - b. Pressure rings are closely sized to fitting inside diameter and outside diameter of casing. They are thick steel plates that have a heavy durable PVC coating, utilizing the very effective fluid bed process.
 - c. Bolts are hex head cap bolts zinc electroplated.
 - d. Neoprene sealing grommets are molded or drilled to accommodate casing outside diameters.
 - e. Oversize sleeves have a marker strip to facilitate field cutting of sleeves to accommodate walls or floors of varying thicknesses.
 2. Cored-Hole Application:
 - a. Conduit sealing bushings are used to seal against fluid and gas pressure around mechanical pipes, casing, conduits or tubes.

- b. Material: Assembled dual pressure disks, neoprene sealing ring, and membrane clamp.

2.3 OUTLET BOXES

- A. Subject to being equivalent and subject to compliance with requirements, provide product by one of the following manufacturers; Appleton, Centaur, Crouse-Hinds, Killark, Lew Electric, Raco, Steel City, Square D, or Thomas and Betts.
- B. Sheet Metal Outlet Boxes:
 - 1. Meet requirements of UL 514A, and NEMA OS-1.
 - 2. Material: galvanized steel, with ½ inch male fixture studs where required.
- C. Cast Aluminum
 - 1. Meet the requirements of UL 514A, and NEMA FB-1. UL listed E-3397.
 - 2. Material: Box shall be powder coated cast copper-free aluminum. The cover shall be powder coated cast copper-free aluminum gasketed and weatherproof with stainless steel screws.
- D. PVC Coated Cast Metal
 - 1. Materials: Cast metal hot-dipped galvanized or urethane finish. Cover shall be of same material as conduit body. PVC coated by conduit manufacturer.
 - 2. Finish: 40-mil PVC exterior, 2-mil urethane interior.
- E. Floor Boxes
 - 1. UL 514A 4.25" x 4.25" x 3" back box for floor pop up receptacles.

2.4 JUNCTION AND PULL BOXES

- A. Subject to being equivalent and subject to compliance with requirements, provide product by one of the following manufacturers; Austin Electrical Enclosures, Crouse Hinds, Eaton, Hoffman, Killark, Neenah, O-Z/Gedney, Saginaw, or Square D.
- B. General
 - 1. Pull boxes no less than the minimum size required by the National Electrical Code Article 314 Interior junction boxes shall be galvanized or powder coated steel. Boxes located on the exterior of the structures or in harsh environments

shall be watertight and constructed of cast aluminum with gasketed covers. Boxes shall be furnished with screw fastened covers.

C. Sheet metal boxes

1. NEMA 250, Type 1, code-gauge, galvanized steel. The cover shall full access, screw type. Boxes larger than 12" shall be provide with hinged covers. Corrosion resistant machine screws.

D. Cast metal boxes

1. Cast malleable iron or ferrous metal, electrogalvanized finished or aluminum, NEMA 250, enclosure rating as shown on the Drawings or per environment classification table below. Box will have drilled and tapped conduit entrances and exterior mounting lugs. The cover shall be hinged with a neoprene gasket and stainless steel hardware and screws.
2. Provide recessed flange cover for outdoor use rated for installed traffic area, pedestrian, vehicle etc.

2.5 WIREWAYS

- A. Subject to being equivalent and subject to compliance with requirements, provide product by one of the following manufacturers; Austin Electrical Enclosures, Eaton, Hoffman, or Square D.
- B. Meet the requirements of UL 870.
- C. Enclosure rating as shown on the Drawings or per environment classification table below.
- D. 14 Gauge steel wireway without knockouts, unless noted otherwise
- E. Hinged or screw applied cover with full gasketing.
- F. Finish: Gray polyester powder coat.

2.6 PRECAST MAN HOLE AND HAND HOLES

- A. Subject to being equivalent and subject to compliance with requirements, provide product by one of the following manufacturers; Armorcast, Foley Products, J&H American Enclosures, Oldcastle, or Qualzite.

- B. Precast Concrete Electric Manhole: Precast concrete electrical manholes shall include thin-wall knockout, cable racks, pull irons, sump box with grate, ground rod sleeve, risers, where required, and a ductile iron frame and cover marked "ELECTRIC."
- C. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Handholes and boxes shall be molded sand and aggregate, bound together with polymer resin, and reinforced with steel or fiberglass or a combination of the two.

2.7 ACCESSORIES

A. Fittings and accessories:

1. Include couplings, offsets, elbows, expansion joints, adapters, hold down straps, end caps, and other fittings to match and mate with wire ways required for complete system. All couplings and connections in locations where water or other liquid or vapor might contact the conduit shall be watertight.

B. Duct sealant:

1. Duct seal putty shall be a gray, permanently soft, non-toxic compound which will adhere to most clean dry surfaces. It shall not adversely affect other plastic materials or corrode metals. Duct seal putty manufacturer shall be Rainbow Technology, Gardner Bender, or equal.

PART 3 - EXECUTION

3.1 INSTALLATION AND APPLICATION

A. Raceways

1. Keep raceways at least 12" away from parallel runs of flues and steam or hot water pipes. Install horizontal raceway runs above water and steam piping.
2. Complete raceway installation before starting conductor installation.
3. All raceway stubs shall be sufficiently plugged or capped during construction to prevent entry of water, debris, mortar, etc.
4. Where non-metallic PVC plastic conduit is installed underground in groups of 3 or more, it shall be installed in duct banks as indicated on the Drawings or where noted otherwise. Duct banks shall be encased in 3,000 psi concrete.
5. All conduits entering boxes, cabinets, panels of similar equipment shall have double locknuts and insulating bushing.

6. A code sized grounding conductor shall be installed in all raceways.
7. All raceways shall be rigidly supported from building structure by rods or hangers attached to building structure. Raceways shall not be attached to any rods or hangers required by other trades. Raceways shall be supported from building construction at intervals as required by the NEC not to exceed 8' with straps and expansion bolts for masonry or concrete construction.
8. All raceways entering cabinets, panels, switchboxes, switchgear, junction boxes, etc. shall be fitted with double bonding locknuts and bushings. One locknut inside and one outside box shall be used. Where conduits terminate in steel or cast NEMA enclosures with no factory installed threaded hubs, a threaded hub shall be installed.
9. Feeder cable conductors shall be pulled into raceways using an approved lubricant. Pull conductors with a pulling eye attached to conductor so not to stretch or injure insulation.
10. Contractor shall be responsible for coordinating proper connection at each item of equipment requiring service and connect accordingly. The term "stub-up and connect" or "connect" used on Drawings implies a full connection as required for each piece of equipment to place it in satisfactory operation. If equipment is equipped with cord and plug, install proper matching receptacle.
11. Conceal conduit within finished walls, ceilings and floors unless otherwise indicated. Install concealed raceways with a minimum of bends in the shortest practical distance considering type of building construction and obstructions, unless otherwise indicated.
12. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200 pound tensile strength. Leave at least 36" of slack at each end of pull wire.
13. Install watertight fittings in outdoor, underground, or wet locations.
14. Horizontal raceways installed under floor slabs shall lie completely under slab, with no part embedded within slab.
15. Install concealed, embedded, and buried raceways so that they emerge at right angles to surface and have no curved portion exposed.
16. Install conduits for fiber optic cables, telephone cables, and Category 6 data cables in strict conformance with the requirements of TIA 569B.
17. Galvanized Rigid Conduit

- a. Rigid steel shall be used for all underground and indoor dry (Lab Building, and Electrical Building) signal raceways. "Signal raceways" shall include all 4/20mA, RS-485, Ethernet, and Fiber Optic signals. See duct bank schedule on the Drawings for details.
18. Rigid Aluminum Conduit
- a. Rigid aluminum shall be used for all exposed raceways except as otherwise noted.
 - b. Exposed conduit shall be rigidly supported by stainless steel or aluminum hardware and framing materials.
 - c. All aluminum conduit installed in contact with concrete or earth shall be protected with aluminum bitumastic paint or tape wraps approved for the purpose.
19. PVC Schedule 40 Rigid Conduit and Tubing:
- a. Use for underground power feeders and branch circuits or where located in interior concealed walls, or ceilings except as otherwise noted and where specifically indicated on Drawings.
 - b. A grounding conductor shall be installed in each non-metallic conduit to maintain grounding continuity.
 - c. Follow manufacturer's recommendations for heat bends and cement application. Install plastic to metallic adapter before emerging from ground or running under building.
 - d. Install expansion fittings for each 100' of unbroken PVC run.
20. PVC-Coated Rigid Galvanized Steel Conduit:
- a. Use for all exposed outdoor signal raceways and conduit in corrosive environments (Headworks, Aeration Basin, Final Clarifiers, Chemical Feed Building and Sludge Dewatering Building).
 - b. All damaged coatings shall be repaired according to the manufacturer's instructions.
21. Flexible Metal, Liquid-Tight Conduit
- a. Use for final connections, maximum 72", to all dry-type transformers, motors, vibrating equipment and in wet or damp installations.

- b. In all liquid-tight flexible steel conduit, provide a green grounding conductor sized per NEC. Bond at fixture, motor, etc., and also bond at box where flexible conduit originates or the next box in line.

B. Junction, pull boxes and wireways

1. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.
2. Concealed conduit systems shall have flush-mounted switches and convenience outlets. Exposed conduit systems shall have surface-mounted switches and convenience outlets. Conduits shall be concealed where practicable.
3. Exterior boxes and outlets shall be securely attached to building structure using expansion bolts for masonry or concrete construction.
4. Covers and collars for manholes shall be level with the finished grade. Build up masonry wall between manhole top and manhole cover collar as required for leveling with finished grade.

Location	Enclosure Type
Indoor dry areas (Lab and Electrical building)	NEMA 1
Wet or corrosive indoor areas (Sludge Building, Chemical Feed Building)	NEMA 4X SS
Outdoor (Headworks, Aeration Basin, Clarifiers, Chlorine Contact Chamber & Post Aeration)	NEMA 4X SS
Class 1, Division 2	NEMA 7

C. Receptacles

1. Receptacles shall be installed vertically 1'-4" above the floor except as noted otherwise.
2. Outlets outdoors and in garages, basements, shops, storerooms, and rooms where equipment may be hosed down; shall be 4' above floor or grade.
3. Conduit and wire for receptacle installation not shown on the Drawings shall be, sized, furnished and installed by Contractor. Conductors shall be minimum 12 AWG, and conduit shall be minimum 3/4" for convenience outlet installation.
4. Install devices and assemblies level, plumb and square with building lines.

5. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.
6. Cover Plates
 - a. Unless otherwise indicated, mount flush, with long dimension vertical, and with grounding terminal of receptacles on top. Group adjacent switches under single, multi-gang wall plates.
 - b. Remove wall plates and protect devices and assemblies during painting.

END OF SECTION

SECTION 262213

LOW VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide labor, material, equipment, related services, and supervision required, including, but not limited to, manufacturing, fabrication, configuration and installation for low voltage distribution dry-type transformers (also identified as transformer, XFMR or T) as required for the complete performance of the work, as shown on the drawings, as specified herein.
- B. RELATED SECTIONS
 - 1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
 - 2. Division 26 Section "Common Work Results for Electrical".

1.2 REFERENCES

- A. The equipment in this specification is designed and manufactured according to latest revision of the following standards (unless otherwise noted).
 - 1. ANSI/IEEE C57.96, Distribution and Power Transformers, Guide for Loading Dry-Type appendix to ANSI C57.12 standards
 - 2. IEEE C57.12.01, General Requirements for Dry-Type Distribution and Power Transformers Including Those with Solid Cast and / or Resin-Encapsulated Windings
 - 3. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC)
 - 4. IEEE C57.12.91, Test Code for Dry-Type Distribution and Power Transformers
 - 5. NEMA ST 20, Dry Type Transformers for General Applications
 - 6. UL 1561, Dry type General Purpose Power Transformer
 - 7. Efficiency level DOE 2016 by 10 CFR PART 431

1.3 DEFINITIONS

- A. Unless specifically defined within the Contract Documents, the words or acronyms contained within this specification shall be as defined within, or by the references listed within this specification, the Contract Documents, or, if not listed by either, by common industry practice.
 - 1. Low-voltage dry-type distribution transformer:
 - a. Has an input voltage of 600V or less
 - b. Has an output voltage of 600V or less
 - c. Covers Step-up and Step- down transformers
 - d. Is rated for operation at a frequency of 60 Hz
 - e. 15 kVA to 1000 kVA for dry-type units
 - f. Is air-cooled; and
 - g. Does not use oil as a coolant

1.4 SUBMITTALS

- A. Submit sufficient information to determine compliance with the Contract Documents. Identify submittal data with the specific equipment tags and/or service descriptions to which they pertain. Submittal data shall be clearly marked to identify the specific model numbers, options, and features of equipment and work proposed.
- B. Deviations from the Contract Documents shall be indicated within the submittal. Each deviation shall reference the corresponding drawing or specification number, show the Contract Document requirement text and/or illustration, and shall be accompanied by a detailed written justification for the deviation.
- C. Manufacturer shall provide copies of following documents to owner for review and evaluation in accordance with general requirements of Division 1 and Division 26.
 - 1. Product data on specified product documenting the following
 - a. Dimensions
 - b. Weight
 - c. KVA
 - d. Voltage

- e. Taps
- f. Insulation Class
- g. Sound level
- h. Wiring Diagram
- i. Installation Instructions available per request

1.5 PROJECT RECORD DRAWINGS

- A. Maintain an up-to-date set of Contract documents. Note any and all revisions and deviations that are made during the course of the project.
- B. Provide final typical outline drawing

1.6 OPERATION AND MAINTENANCE DATA

- A. Manufacturer shall provide copies of installation, operation and maintenance procedures to owner in accordance with general requirements of Division 1 and Division 26.
- B. Submit operation and maintenance data based on factory and field testing, operation and maintenance of specified product.

1.7 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Manufacturer shall be a firm engaged in the manufacture of specified products of types and sizes required, and whose products have been in satisfactory use in similar service for a minimum of ten years.
 - 1. The manufacturer shall have a valid ISO 9001 certification and an applicable quality assurance system that is regularly reviewed and audited by a third-party registrar. Manufacturing, inspection, and testing procedures shall be developed and controlled under the guidelines of the quality assurance system.
- B. All work performed and all materials used shall be in accordance with the National Electrical Code, and with applicable local regulations and ordinances. Equipment, assemblies and materials shall be listed and labeled by Underwriter's Laboratories or by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect, and handle products in accordance with the manufacturer recommendations.
- B. Dry type transformers shall be located in well-ventilated areas, free from excess humidity, dust and dirt and away from hazardous materials. Indoor locations shall be protected to prevent moisture from entering enclosure.
- C. Equipment shall be shipped with edge and top protection that is adequate to protect the transformer enclosure from common dents and scratches.

1.9 WARRANTY

- A. Manufacturer warrants equipment to be free from defects in materials and workmanship for 1 year from date of installation or 18 months from date of purchase, whichever occurs first.

PART 2 - PRODUCTS

2.1 MANUFATURER

- A. GE by ABB products have been used as the basis for design. Other manufactures' products of equivalent quality, dimensions and operating features may be acceptable, at the Engineer's discretion, if they comply with all requirements specified.
- B. Other pre-approved manufacturers.
 - 1. Square D
 - 2. Eaton

2.2 GENERAL REQUIREMENTS

- A. Dry type general purpose transformers shall be rated as indicated in the drawings
- B. Comply with NEMA ST 20, and list and label as complying with UL 1561
- C. Cores: One leg per phase
- D. Enclosure: Ventilated, NEMA 250, Type 2 for indoor locations, Type 3R for outdoor locations.
- E. Transformers supplied to this specification shall be able to operate continuously at 100 percent nameplate rating at ambient temperature not exceeding 40 degrees C.

- F. Insulation Class: 220 degrees C, UL recognized insulation system with a maximum of 150, 115 or 80 deg C rise above 40 deg C ambient temperature. Temperature rise ratings shall be in accordance with UL 1561.
- G. Transformer shall have self-cooled sound levels equal to or lower than those established by ANSI/IEEE

Equivalent Winding KVA range	K-Factor 1 K-Factor 4 K-Factor 9	K- Factor 13 K-Factor 20
9.00 and below	40	40
9.01 to 50.00	45	48
50.01 to 150.00	50	53
150.01 to 300.00	55	58
300.01 to 500.00	60	63
500.01 to 700.00	62	65
700.01 to 1000.00	64	67

- H. Transformer shall be sound tested in the factory prior to shipment. A record of the sound testing can be obtained from the manufacturer upon request (additional cost applies).
- I. Transformers shall meet the energy efficiency requirements of 10 CFR PART 431 2016.

Single-phase	
kVA	Efficiency (%)
15	97.70
25	98.00
37.5	98.20
50	98.30
kVA	Efficiency (%)

75	98.50
100	98.60
167	98.70
250	98.80
333	98.90

Three-phase	
kVA	Efficiency (%)
15	97.89
30	98.23
45	98.40
75	98.60
112.5	98.74
150	98.83
225	98.94
300	99.02
500	99.14
750	99.23
1000	99.28

- J. Transformers shall carry the fully rated load continuously when the surrounding air does not exceed 30°C/86F, 40°C/140F maximum and adjacent structures do not prohibit the free movement of cooling air according installation manual.
- K. Transformers 5 KVA and above shall be able to meet ANSI/IEEE C57.96 daily overload requirements listed in drawings. Transformers loaded in accordance with this

paragraph shall be capable of long service life under thermal conditions specified. There shall be no need for derating.

L. Enclosures shall meet UL 506 requirements for the following characteristics:

1. Ventilation Openings;
2. Corrosion Resistance;
3. Cable Bending Space;
4. Surface Temperature Rise;
5. Wiring Compartment Temperature Rise;
6. Terminations.
7. Brushed Stainless Steel 316 available for capacities 15 to 150 kVA

M. Transformer Construction

1. Transformer core shall be constructed of high grade, non-aging silicon steel with high magnetic permeability and low hysteresis and eddy current losses. Magnetic flux densities shall be kept well below core saturation point. Transformer core shall be clamped by bolts through the core laminations to provide consistent pressure throughout the core length. Completed core and coil shall be bolted to enclosure base and isolated from base by rubber vibration-absorbing mounts.
2. Transformer core shall be visibly grounded to enclosure.
3. Enclosure shall be constructed of heavy gauge steel.
4. Coils shall be copper.

2.3 ACCESSORIES

A. Accessories for 15 kVA to 500 kVA are available as spare parts or as additional feature:

1. Weathershield kits.
2. Front kit
3. Side kit
4. Cover kit
5. Lug kits

6. Enclosure kit
7. Bottom pan kit
- B. Accessories included in transformers from 15 kVA to 150 kVA (Except for Stainless steel or special transformers)
 1. Lug kits
 2. Ground kits
- C. Accessories for transformers from 15 kVA to 112.5 kVA should be available as additional option.
 1. Wall mounting brackets
- D. Accessories included in transformers from 15 kVA to 500kVA
 1. Isomode pad kit

2.4 LOAD TAPS

- A. Transformers shall have following high voltage load tap arrangements unless noted otherwise in plans:
 1. Taps for transformers smaller than 3 KVA - no taps;
 2. Taps for transformers 3 through 25 KVA - [no taps] [2, 5 percent taps, both below nominal voltage] [4, 2-1/2 percent taps, 2 above, 2 below nominal voltage];
 3. Taps for transformers 25 kVA to 300 KVA – Two 2.5 percent taps above and four 2.5 percent below normal full capacity.
 4. Taps for transformer 500 KVA - Two 2.5 percent taps above, 2 below nominal voltage
 5. Taps for 750 KVA – one tap above and one tap below at 5 percent of the nominal voltage

2.5 TESTING

- A. Transformers furnished to this specification shall receive the following production tests:
 1. Applied Potential
 2. Induced Potential

3. No Load Losses
 4. Voltage Ratio
 5. Polarity
 6. Continuity
- B. Manufacturer shall perform the following additional tests on units identical to the design type being supplied to this specification. Manufacturer shall provide on request test data sheets to prove performance of these tests.
1. Sound Levels
 2. Temperature Rise Tests
 3. Full-Load Losses
 4. Regulation
 5. Impedance

2.6 MARKINGS AND LABELING

- A. All identification, warning labels and nameplates mounted on the exterior shall be resistant to weather, UV, and their intended installation environment.
- B. Nameplate shall contain the minimum information required by latest version of NEC and NEMA ST-20 and be part of a UL Component Recognized outdoor marking system
- C. Other information shall also be supplied
1. Efficiency Level @ 35% loading correct for 75°C temperature
 2. DOE 10 CFR 429 Data base identifier
 3. Statement on Nameplate identifying that it is a Distribution Transformer, or why it is not
 - a. Meets Final Rule US 10 CFR 431 April 2013

2.7 Warning labels and nameplates shall be present at access locations to advise personnel of possible hazards.

2.8 FINISH

- A. Finish shall consist of coated powder paint ANSI 61 gray.

PART 3 - EXECUTION

3.1 GENERAL

- A. In addition to the requirements specified herein, execution shall be in accordance with the requirements of Specification Division 26 and Drawings.

3.2 EXAMINATION

- A. Examine equipment exterior and interior prior to installation. Report any damage and do not install any equipment that is structurally, moisture, or mildew damaged.
- B. Verification of Conditions: Examine areas and conditions under which the work is to be installed, and notify the Contractor in writing, with a copy to the Owner and the Engineer, of any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.
- C. Verify field measurements are as instructed by manufacturer.
- D. Electrical Contractor to verify that required utilities are available.
- E. Electrical Contractor has obtained all necessary data to install the unit.

3.3 LOCATION

- A. Electrical Contractor to verify proper location for the unit.
- B. The transformer shall be installed in a location where the sides with ventilated openings are a minimum distance of six inches from noncombustible structures or equipment to ensure adequate air circulation.

3.4 INSTALLATION

- A. If transformer needs to be stored, follow manufacture instructions – (storage shall also include after installation, if units are not immediately energized)

1. During storage make sure all ventilated openings do not allow for dust or other debris to enter transformers
 2. Transformer cannot be stored outdoors, even if Type 3R, without maintaining uniform temperature above dew point
- B. Mount transformers per drawings, location shall be readily accessible. When mounted on walls, columns, or other support structure in visible site are not required to be readily accessible.
1. Verify that minimum distance from rear and side are in compliance with manufacture drawings and information on nameplate
- C. Using Flexible raceways, conduits, and connectors – connected in locations identified by manufacture drawings or instruction manuals
- D. Land wire on proper terminals, tight all connections via calibrated torque wrench
- E. Grounding – comply with Electrical Code and manufacturer’s instructions
1. Ground Bar or Ground Bus
 2. Verify that core assembly is factory grounded to enclosure
- F. Bonding – comply with Electrical Code and manufacturer’s instructions
- G. In accordance with NEC Section 450-9, allow at least 6 inches clearance for ventilation.

3.5 FIELD QUALITY CONTROL

- A. Inspect installed dry type transformers for anchoring, alignment, grounding and physical damage.
- B. Check tightness of all accessible mechanical and electrical connections with calibrated torque wrench. Minimum acceptable values are specified in manufacturer's instructions.

3.6 TESTING

- A. Established safety procedures shall be followed including but not limited to
 1. Proper Personal Protective Equipment, accordance with incident energy levels
- B. Megger Transformer to verify all connections are cleared from ground
- C. Take Measurements of Primary Voltages – match nameplate

- D. Take Measurements of Secondary Voltages – match nameplate
- E. With front cover installed verify that the transformer when energized is not emitting excess if noise – contact manufacture if noise is not 120 hertz constant hum

3.7 CLEANING

- A. Repaint scratched or marred exterior surfaces to match original finish.

END OF SECTION

SECTION 262416

PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide labor, material, equipment, related services, and supervision required, including, but not limited to, manufacturing, fabrication, configuration and installation for lighting and appliance panelboards or power panelboards as required for the complete performance of the work, as shown on the drawings, as specified herein, and as specified elsewhere for the assemblies or systems comprised of the components specified herein.

1.2 RELATED SECTIONS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Division 26 Section "Common Work Results for Electrical".
- C. Section 26 28 11 Molded Case Circuit Breakers

1.3 REFERENCES

- A. The lighting and appliance panelboards or power panelboards and protection devices in this specification are designed and manufactured according to latest revision of the following standards (unless otherwise noted).
 - 1. NEMA AB 1, "Molded Case Circuit Breakers and Molded Case Switches."
 - 2. ANSI/NEMA PB 1, Panelboards
 - 3. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC)
 - 4. ASTM - American Society of Testing Materials
 - 5. CSA C22.2 No. 29, Panelboards and Enclosed Panelboards
 - 6. CSA C22.2 No. 5.1, Molded Case Circuit Breakers
 - 7. Federal Specification W-C-375, Rev. B, Amend. 1, Circuit Breakers, Molded Case; Branch Circuit and Service

8. Federal Specification W-P 115, Rev. C, Panel, Power Distribution
9. NEMA AB 1, Molded Case Circuit Breakers, Molded Case Switches, and Circuit Breaker Enclosures
10. ANSI/NEMA PB 1.1, General Instructions for Proper Installation, Operation, and Maintenance of Panelboards Rated 600 Volts or Less
11. UL 489, Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures
12. UL 50, Enclosures for Electrical Equipment, Non-Environmental Considerations
13. UL 67, Panelboards

1.4 SYSTEM DESCRIPTION

- A. Lighting and appliance panelboards or power panelboards shall be suitable for use on power systems with nominal voltage ratings and short circuit current ratings indicated on drawings.
- B. Short circuit rating of lighting and appliance panelboards or power panelboards shall be the interrupting rating of lowest rated device in the panel or applicable UL series rating for proper main and branch device combinations.
- C. Panelboard breakers shall be plug-in style with at least one bolt to attach the breaker to panelboard structure. Conventional bolt-on style breakers are also acceptable.
- D. Protective devices shall be molded case circuit breakers (MCCB).

1.5 SUBMITTALS

- A. Manufacturer shall provide copies of following documents to owner for review and evaluation in accordance with general requirements of Division 1 and Division 26:
- B. Submit sufficient information to determine compliance with the Contract Documents. Identify submittal data with the specific equipment tags and/or service descriptions to which they pertain. Submittal data shall be clearly marked to identify the specific model numbers, options, and features of equipment and work proposed.
- C. Deviations from the Contract Documents shall be indicated within the submittal. Each deviation shall reference the corresponding drawing or specification number, show the Contract Document requirement text and/or illustration, and shall be accompanied by a detailed written justification for the deviation.
- D. Product Data on specified product;

- E. Shop Drawings on specified product;

1.6 PROJECT RECORD DRAWINGS

- A. Maintain an up-to-date set of Contract documents. Note any and all revisions and deviations that are made during the course of the project.

1.7 OPERATION AND MAINTENANCE DATA

- A. Manufacturer shall provide copies of installation, operation and maintenance procedures to owner in accordance with general requirements of Division 1 and Division 26.
- B. Submit operation and maintenance data based on factory and field testing, operation and maintenance of specified product.

1.8 QUALITY ASSURANCE

- A. Manufacturer shall have specialized in the manufacture and assembly of lighting and appliance panelboards or power panelboards for 50 years.
- B. Lighting and appliance panelboards or power panelboards shall be listed and/or classified by Underwriters Laboratories in accordance with standards listed in Article 1.3 of this specification.
- C. Installer has specialized in installing power panelboards.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect, and handle products in accordance with recommended practices in manufacturer's Installation and Maintenance Manuals.
- B. Deliver each lighting panelboard in individual shipping cases for ease of handling. Each panelboard shall be wrapped for protection.
- C. Installer shall inspect and report concealed damage to carrier within specified time.
- D. Store in a clean, dry space. Maintain factory protection or cover with heavy canvas or plastic to keep out dirt, water, construction debris, and traffic. (Heat enclosures to prevent condensation.)
- E. Handle in accordance with NEMA and manufacturer's written instructions to avoid damaging equipment, installed devices, and finish.

1.10 PROJECT CONDITIONS

- A. Follow (standards) service conditions before, during and after panelboard installation.
- B. Lighting and appliance panelboards or power panelboards shall be located in well-ventilated areas, free from excess humidity, dust and dirt and away from hazardous materials. Ambient temperature of area will be between minus 5 and plus 40 degrees C. Indoor locations shall be protected to prevent moisture from entering enclosure.

1.11 WARRANTY

- A. Manufacturer warrants equipment to be free from defects in materials and workmanship for 1 year from date of installation or 18 months from date of purchase, whichever occurs first.

1.12 FIELD MEASUREMENTS

- A. Make all necessary field measurements to verify that equipment shall fit in allocated space in full compliance with minimum required clearances specified in National Electrical Code.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. General Electric by ABB ReliaGear or equal by Schneider or Eaton.

2.2 COMPONENTS

- A. Refer to Drawings for: actual layout and location of equipment and components; current ratings of devices, bus bars, and components; voltage ratings of devices, components and assemblies; and other required details.
- B. Ratings
 - 1. Lighting and appliance panelboards or power panelboards shall be rated as indicated in drawings.
 - 2. Maximum current ratings for mains and feeders, respectively, shall be specified in drawings.
- C. Enclosure
 - 1. Enclosure shall be as indicated on Drawings.

2. All panelboard series ratings shall be prominently displayed on dead front shield.
3. Interiors shall permit top or bottom incoming cables.

D. Bus bars

1. Bus bars shall be phase sequenced, fully insulated, and finger safe.
2. Bus bars shall be mechanically supported to prevent vibration and damage from short circuits.
3. Terminations shall be UL tested and listed and suitable for conductors furnished.
4. Lugs shall be rated for 75 degree C terminations.

E. Circuit Breakers – General Requirements

1. Molded case circuit breakers shall be bolt-on.
2. MCCBs may be thermal magnetic or solid state as required for the particular application.
3. All breakers shall have handle trip indication.
4. Breaker handle and faceplate shall indicate rated ampacity.
5. Circuit breaker escutcheon shall have standard ON/OFF markings.

F. Main and Circuit Breakers

1. Main circuit breakers may be vertically or horizontally mounted.
2. Main breakers shall be UL listed for use with: Mechanical Lug Kits.
3. Main breakers in panels rated up to 1200A shall have fixed thermal magnetic trip units or adjustable thermal magnetic trip units or adjustable solid state trip units.

2.3 ACCESSORIES

- A. Locking devices for breakers and or operating handles if indicated on drawings
- B. Furnish nameplates for each device as indicated in drawings. Color schemes shall be as indicated on drawings.
- C. Provide an integrally mounted surge protective device (SPD) where indicated on drawings. Device shall be ABB TPHE Series or TPME Series SPDs, or equal by Schneider or Eaton that complies with all of the following.

1. SPD shall be factory installed as an integral part of the panelboard, complying with UL 1449 SPD, Type 2, with the following features and accessories:
 - a. SPD Ratings
 - 1) Maximum Single Impulse Surge Current Rating shall be 100 kA per mode and shall be based on the testing of a complete SPD including fuses and all components that make up the SPD assembly using an IEEE C62.41, 8x20us current wave applied at the maximum, per mode rated value of the SPD. Devices that derive a per mode rating by adding test results of individual components are not acceptable.
 - 2) Surge Life Rating shall be a minimum of 5,000 IEEE C62.41 C-High (C3) impulses and shall be determined by the application of an 8x20us, 10kA short circuit Category C High test waveform across the SPD as defined by ANSI/IEEE C62.41.2-2002. The test wave shall be injected at one-minute intervals until the conclusion of the test or device failure. A failure is defined as either performance degradation or more than 10% deviation of clamping voltage at the specified surge current.
 - 3) UL 1449 Nominal Discharge Current Rating (In): 20kA
 - b. The SPD shall be provided with the following features:
 - 1) Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
 - 2) Indicator light display for protection status.
 - 3) Form-C contacts rated at 5-A and 250-V ac, one N.O. and one N.C., for remote monitoring of protection status.
 - 4) Surge counter

2.4 FINISH

- A. Boxes shall be corrosion resistant.
- B. Fronts shall be powder finish painted ANSI 61 gray.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that panelboards are ready to install.
- B. Verify field measurements are as instructed by manufacturer.
- C. Verify that required utilities are available, in proper location and ready for use.
- D. Beginning of installation means installer accepts conditions.

3.2 INSTALLTION

- A. Install per manufacturer's instructions.
- B. Install required safety labels.

3.3 FIELD QUALITY CONTROLS

- A. Inspect installed panelboards for anchoring, alignment, grounding and physical damage.
- B. Check tightness of all accessible mechanical and electrical connections with calibrated torque wrench. Minimum acceptable values are specified in manufacturer's instructions.
- C. Test each key interlock system for proper functioning.

3.4 ADJUSTING

- A. Adjust all circuit breakers, access doors, operating handles for free mechanical and / or electrical operation as described in manufacturer's instructions.

3.5 CLEANING

- A. Clean interiors of panels to remove construction debris, dirt, shipping materials.
- B. Repaint scratched or marred exterior surfaces to match original finish.

END OF SECTION

SECTION 262726

WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide labor, material, equipment, related services, and supervision required, including, but not limited to installation, connections and testing of all wiring devices and accessories as required for the complete performance of the work, as shown on the Drawings, as specified herein.
- B. RELATED SECTIONS
 - 1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
 - 2. Division 26 Section "Common Work Results for Electrical".

1.2 REFERENCES

- A. The equipment in this specification is designed and manufactured according to latest revision of the following standards (unless otherwise noted).
 - 1. National Electrical Contractors Association (NECA):
 - 2. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC)
 - 3. National Electrical Manufacturers Association (NEMA) FB 11, WD 1, and WD 6
 - 4. Underwriters Laboratories (UL) 498, 943

1.3 SUBMITTALS

- A. Submit sufficient information to determine compliance with the Contract Documents. Identify submittal data with the specific equipment tags and/or service descriptions to which they pertain. Submittal data shall be clearly marked to identify the specific model numbers, options, and features of equipment and work proposed.
- B. Deviations from the Contract Documents shall be indicated within the submittal. Each deviation shall reference the corresponding drawing or specification number, show the

Contract Document requirement text and/or illustration, and shall be accompanied by a detailed written justification for the deviation.

- C. Manufacturer shall provide copies of following documents to owner for review and evaluation in accordance with general requirements of Division 1 and Division 26.
 - 1. Product data on specified product documenting the following
 - a. Data Jacks
 - b. Receptacles
 - c. Switches
- D. Provide a guarantee against defective materials and workmanship in accordance with requirements of the Section 260500 of these Specifications.

PART 2 - PRODUCTS

2.1 DATA AND TELEPHONE JACKS

- A. Subject to being equivalent and subject to compliance with requirements, provide product by one of the following manufacturers; Hubbel, Leviton, or Panduit.
- B. Telephone and data jack UL 1863, compatible with Category 5, 5e, and 6a cable.

2.2 RECEPTACLES

- A. Subject to being equivalent and subject to compliance with requirements, provide product by one of the following manufacturers; Arrow Hart, Bryant, Hubbel, Leviton, Pass & Seymour, or Square D.
- B. General purpose receptacles NEMA WD 1, Configuration 5-15R, 15 amps, 125 volts, unless otherwise indicated.
- C. Corrosion resistant receptacles NEMA WD 1, UL 498, Nylon face, Configuration 5-20R, 20 amps, 125 volts, Industrial Extra Heavy Duty, unless otherwise indicated.
- D. Ground fault circuit interrupter receptacles UL 943, NEMA WD 1, Configuration 5-15R, 15 amps, 125 volts, unless otherwise indicated.

2.3 SWITCHES

- A. Subject to being equivalent and subject to compliance with requirements, provide product by one of the following manufacturers; Arrow Hart, Bryant, Hubbel, Leviton, or Pass & Seymour.
- B. General purpose switches shall be NEMA WD 1, AC type, extra-heavy duty industrial grade, 15amp, 277Volt. Provide 3- or 4-way switches as shown on the Drawings.
- C. Motor rated switches shall be UL 508, two or three-pole totally enclosed switch, 30amp, 600Volt.
- D. Provide switches with occupancy sensor where shown on the Drawings.

2.4 COVER PLATES

- A. Provide and install single and combination types to match corresponding wiring devices. Oversized plates shall be installed where standard-sized plates do not fully cover the wall opening.
- B. Cover plates for recessed, wiring devices shall be stainless steel unless shown otherwise.
- C. Cover plates, trim rings, etc. for recessed, floor-mounted electrical items shall match finish of building hardware (stainless steel, brass, etc.) in area installed.
- D. Cover plates for exposed wiring devices shall be of same material as exposed outlet boxes
- E. Weather proof cover plates shall be in-use type rated for use in wet locations per the NEC.

2.5 FINISHES

- A. All wiring devices (switches, receptacles, etc.) shall be gray in color unless noted otherwise.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Conduit and wire for receptacle installation not shown on the Drawings shall be, sized, furnished and installed by Contractor. Conductors shall be minimum 12 AWG, and conduit shall be minimum $\frac{3}{4}$ " for convenience outlet installation.

- B. Install devices and assemblies level, plumb and square with building lines.
- C. Unless otherwise indicated, mount flush, with long dimension vertical, and with grounding terminal of receptacles on top. Group adjacent switches under single, multi-gang wall plates.
- D. Remove wall plates and protect devices and assemblies during painting.
- E. It is the Contractor's responsibility to coordinate with all trades to secure correct wiring device installation locations. Adjust locations of floor service outlets and wiring devices to suit arrangement of partitions and furnishings.
- F. Mounting Height
 - 1. Approximate dimensions to the centerline of the device box are listed below. The exact locations and mounting heights shall be determined in the field, and it is the Contractor's responsibility to coordinate with all trades to secure correct installation. Where specified heights do not suit building construction or finish, adjust up or down to avoid interference. Do not straddle CMU block or other construction joints. Verify door swings with Architectural plans.
 - 2. Install light Switches 48 inches above floor, when located next to door, install opening side of door.
 - 3. Install general interior convenience receptacles 16 inches above floor. unless noted otherwise on the Drawings.
 - 4. For countertop installations, install device plate bottom flush with top of backsplash, or 6 inches above counter tops without backsplash.
 - 5. In garages, basements, shops, storerooms, and rooms where equipment may be hosed down and outdoors install wiring devices 48 inches above floor unless noted otherwise on the Drawings.
 - 6. Install special-purpose receptacles 48 inches above floor unless noted otherwise on the Drawings.

3.2 IDENTIFICATION

- A. Use tape labels for identification of individual wall switches and receptacles in dry indoor locations.
 - 1. Use black letters on white background, unless noted otherwise.
 - 2. Identify panelboard and circuit number from which item is served on face of plate.

3. Identify conductors with wire markers or tags inside outlet boxes.

END OF SECTION

SECTION 262816
SAFETY SWITCHES

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide labor, material, equipment, related services, and supervision required, including, but not limited to, manufacturing, fabrication, configuration and installation for low voltage safety switches as required for the complete performance of the work, as shown on the drawings, as specified herein.
- B. RELATED SECTIONS
 - 1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
 - 2. Division 26 Section "Common Work Results for Electrical".

1.2 REFERENCES

- A. As applicable to the specifics of the project drawings and the specifics of the application for this project, the low voltage safety switches, shall be designed and manufactured according to latest revision of the following standards (unless otherwise noted on the project drawings or annotated in any sections below).
 - 1. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC)
 - 2. NEMA KS 1, Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum)
 - 3. UL 98, Enclosed and Dead Front Switches

1.3 DEFINITIONS

- A. General Duty. Designed for residential and light commercial where duty is not severe. Rated 240Vac or 250Vdc maximum.
- B. Heavy Duty. Designed for applications where safety, high performance and continuity of service is required. Rated at 600Vac or 600Vdc maximum.

- C. Mill Duty. Designed for mill, foundry and industrial applications where safety, high performance and continuity of service is required. Rated at 600Vac or 600Vdc maximum.
- D. Double Throw. Designed for applications where the ability to switch between either (2) sources or (2) loads is required. Rated 600 Vac or 250Vdc maximum.
- E. Standby Power Transfer. Designed for applications to permit the connection of power from a standby generator or other source of electricity and are ideally suited for outdoor applications in rural dwellings and farm buildings. Rated 120/240Vac or 240V maximum.
- F. NEMA 1 Enclosures. Indoor use to provide a degree of protection to personnel against access to hazardous parts and to provide a degree of protection of the equipment inside the enclosure against ingress of solid foreign objects (falling dirt).
- G. NEMA 3R Enclosures. Enclosures constructed for either indoor or outdoor use to provide a degree of protection to personnel against access to hazardous parts; to provide a degree of protection of the equipment inside the enclosure against ingress of solid foreign objects (falling dirt); to provide a degree of protection with respect to harmful effects on the equipment due to the ingress of water (rain, sleet, snow); and that will be undamaged by the external formation of ice on the enclosure.
- H. NEMA 4 Enclosures. Indoor or outdoor use to provide a degree of protection to personnel against access to hazardous parts; to provide a degree of protection of the equipment inside the enclosure against ingress of solid foreign objects (falling dirt and windblown dust); to provide a degree of protection with respect to harmful effects on the equipment due to the ingress of water (rain, sleet, snow, splashing water, and hose directed water); that provides an additional level of protection against corrosion; and that will be undamaged by the external formation of ice on the enclosure.
- I. NEMA 4X Enclosures. Indoor or outdoor use to provide a degree of protection to personnel against access to hazardous parts; to provide a degree of protection of the equipment inside the enclosure against ingress of solid foreign objects (windblown dust); to provide a degree of protection with respect to harmful effects on the equipment due to the ingress of water (rain, sleet, snow, splashing water, and hose directed water); that provides an additional level of protection against corrosion; and that will be undamaged by the external formation of ice on the enclosure.
- J. NEMA Type 5 Enclosures. Indoor or outdoor use to provide a degree of protection to personnel against access to hazardous parts; to provide a degree of protection of the equipment inside the enclosure against ingress of solid foreign objects (falling dirt and settling airborne dust, lint, fibers, and flyings); and to provide a degree of protection with respect to harmful effects on the equipment due to the ingress of water (dripping and light splashing, hose directed water and the entry of water during occasional temporary submersion at a limited depth) and that will be undamaged by the external formation of ice on the enclosure.

- K. NEMA Type 12 Enclosures. Constructed for indoor use to provide a degree of protection to personnel against access to hazardous parts; to provide a degree of protection of the equipment inside the enclosure against ingress of solid foreign objects (falling dirt and circulating dust, lint, fibers, and flyings); and to provide a degree of protection with respect to harmful effects on the equipment due to the ingress of water (dripping and light splashing).
- L. UL Listed and cUL Listed. Products that have been tested by Underwriters Laboratories and have met the construction and performance requirements of the applicable UL standards number.

1.4 SUBMITTALS

- A. Submit sufficient information to determine compliance with the Contract Documents. Identify submittal data with the specific equipment tags and/or service descriptions to which they pertain. Submittal data shall be clearly marked to identify the specific model numbers, options, and features of equipment and work proposed.
- B. Deviations from the Contract Documents shall be indicated within the submittal. Each deviation shall reference the corresponding drawing or specification number, show the Contract Document requirement text and/or illustration, and shall be accompanied by a detailed written justification for the deviation.
- C. The contractor/installer shall provide electronic copies of the following documents in PDF format as APPROVAL drawings to the engineer/owner for review and evaluation. It is preferred that the drawing format be provided in letter/size “A” (8.5” x 11”) or tabloid/size “B” (11” x 17”) format to facilitate easy copying. Manufacturing of the equipment will not begin until the submitted documents are stamped/noted “approved” or “approved as noted” by the engineer/owner and officially released for manufacturer by the contractor/installer/distributor/owner.
- D. APPROVAL documents for the specified product shall include:
 - 1. Safety Switch Information Drawing – by the equipment manufacturer. This “by each type” document shall contain at least the following information for each type of safety switch on the project. For exactly identical types, quantities of the safety switches shall also be indicated.
 - a. Overall enclosure dimensions
 - b. Number of switching poles
 - c. Current rating
 - d. Voltage rating

- e. Knockout dimensions
 - f. Horsepower rating (if applicable)
 - g. Neutral connection / block (if applicable)
 - h. Ground connection / block
2. Safety Switch Brochure – detailing the general construction of the product – by the equipment manufacturer
- E. The contractor/installer shall provide electronic copies of the following documents in PDF format to reflect the AS BUILT condition of the equipment to the engineer/owner for their record documentation. It is preferred that the drawing format be provided in letter/size “A” (8.5” x 11”) or tabloid/size “B” (11” x 17”) format to facilitate easy copying. ‘D. AS BUILT documents for the specified product shall include:
- 1. Safety Switch Information Drawing – by the equipment manufacturer. This “by each type” document shall contain at least the following information for each type of safety switch on the project. For exactly identical types, quantities of the safety switches shall also be indicated.
 - a. Overall enclosure dimensions
 - b. Number of switching poles
 - c. Current rating
 - d. Voltage rating
 - e. Knockout dimensions
 - f. Horsepower rating (if applicable)
 - g. Neutral connection / block (if applicable)
 - h. Ground connection / block

1.5 QUALITY ASSURANCE

- A. The manufacturer shall have specialized in the manufacture of low voltage safety switches for at least 15 years.
- B. The low voltage safety switches shall be listed and/or classified by Underwriters Laboratories in accordance with standards listed in the “REFERENCES” section of this specification above.

- C. Equipment shall be qualified for use in for any site with a site specific SDS equal or less than the values below and at any location within a building as follows:
 - 1. High seismic loading as defined in IEEE Std 693-2005, with 1.33 amplification factor.
 - 2. IBC-2015, $I_p = 1.5$, for z/h equal to in accordance with ICC-ES-AC156.
 - a. NEMA 1/3R/5/12, 30A – 100A: Sds = 2.71 g
 - b. NEMA 1/3R/5/12, 200A – 600A: Sds = 1.59 g
 - c. NEMA 1/3R/5/12, 800A – 1200A: Sds = 1.21 g
 - d. NEMA 4/4X, 30A – 600A: Sds = 1.22 g
 - 3. The safety switches shall be seismic certified as documented in OSP-0320-10.
 - 4. Seismic compliance shall be qualified only through shake table testing.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. The manufacturer shall ship each safety switch in an individual carton for ease of handling.
- B. The contractor/installer shall inspect and if necessary, report any concealed damage to carrier within 48 hours of the safety switches being delivered. The contractor/installer shall be responsible for all claims with the shipper.
- C. The contractor/installer shall store the safety switches in a clean, dry space and shall maintain factory protection and/or cover the products with heavy canvas or plastic to keep out dirt, water, construction debris, and traffic.
- D. The contractor/installer shall handle the safety switches in accordance with all appropriate NEMA instructions to avoid damaging them.

1.7 PROJECT CONDITIONS (SITE ENVIRONMENTAL CONDITIONS)

- A. The contractor/installer shall follow all appropriate standards and service conditions before, during and after the safety switch installation.
- B. The safety switches shall be located in well ventilated areas, free from excess humidity, dust and dirt and away from hazardous materials.
- C. Indoor locations shall be protected to prevent moisture from entering enclosure.

1.8 WARRANTY

- A. Manufacturer warrants equipment to be free from defects in materials and workmanship for 1 year from date of installation or 18 months from date of purchase, whichever occurs first.

PART 2 - PRODUCTS

2.1 MANUFATURER

- A. GE by ABB products have been used as the basis for design. Other manufacturers' products of equivalent quality, dimensions and operating features may be acceptable, at the Engineer's discretion, if they comply with all requirements specified or indicated in these Contract documents. The following equipment shall be provided:

1. ABB
2. Square D
3. Eaton

2.2 PRODUCT INFORMATION

- A. Refer to the project drawings and the safety switch schedules for the locations and quantities. The drawings and schedules shall also include information about the current and voltage ratings of devices.
- B. Product Requirements
 1. An extra-large, legible ON/OFF label shall be provided on the front door cover of the switch for switch on – off position indication.
 2. The box mounted operation handle shall be a highly visible bright red color to provide easy identification of the switch position and shall directly drive the switch mechanism.
 3. The switch operation handle shall be capable of being padlocked in the OFF position with up to three padlocks with 5/16 inch diameter shanks. The handle on Heavy Duty or Mill Duty switches shall have a “donut” configuration to allow operation by a hook stick.
 4. All movable contacts shall be silver plated. Heavy Duty switches, 30A through 200A, 600V or 600Vdc, shall have clear line shields to allow visual confirmation of plated blade position while helping to protect against accidental contact with live parts.

5. A wide wiring gutter, clear of obstructions and moving parts shall be provided. The interior shall be easily removable and contain line and load copper/aluminum lugs suitable for use with 60 degree C and 75 degree C conductors.
 6. The switch shall be suitable for use as service entrance equipment when installed in accordance with National Electrical Code unless otherwise specified.
 7. The enclosure finish shall consist of degreasing, phosphate cleaning, and an electro-deposit of the manufacturer's standard gray enamel paint.
 8. Heavy Duty switches shall have defeatable, front access, coin-proof interlocks. These interlocks shall prevent opening the switch door when switch is ON and prevent turning the switch ON when door is open. The interlocks must, however, allow entrance into the enclosure when the switch is OFF without the use of tools for "Contact Open" inspection.
 9. General Duty switches up through 200A shall have interlocks that prevent opening the switch door when switch is ON.
 10. Double-throw switches shall have interlocks to prevent opening the switch door when switch is ON and prevent turning the switch ON when door is open. However, the interlocks must allow entrance into the enclosure when the switch is OFF without the use of tools for "Contact Open" inspection.
 11. Should class J fuses be required on the project, the contractor/installer shall relocate the load side fuse block holder of Heavy Duty or Double Throw switches from the standard "Class H/R Fuse Location" to the "Class J Fuse Location".
 12. Some fuses require kits. Reference the rating label of the switch or publication DET-845 for specific kit numbers
- C. Voltage Rating. Refer to the project drawings and safety switch schedules for the appropriate voltage rating of each switch.
- D. Continuous Current Rating. Refer to the project drawings and safety switch schedules for the required ampere ratings of each switch.
- E. Short Circuit Current Rating
1. Refer to the project drawings and safety switch schedules for the required short circuit rating.
 2. Fusible safety switches shall have a minimum short circuit rating per the table listed below. This rating shall be equal to or greater than the short-circuit available from all sources. The contractor/installer shall provide and install the appropriate fuses to achieve the required AIC rating. The switches shall also

contain a label showing the appropriate short circuit value at the rated voltage with the proper fuses installed.

Minimum Fusible Safety Switch Withstand Current Ratings			
Switch Type	Max. System Voltage	Fuse Class	Withstand Rating (Symmetrical Amps)
General Duty	250 Vac / 250 Vdc	K	10,000
		H	10,000
		R	100,000
Heavy Duty	600 Vac / 250 Vdc	H	10,000
		R	200,000
		J	200,000
		L	100,000
Double Throw	600 Vac / 250 Vdc	R	100,000
		J	100,000
		T	100,000
		L	100,000

3. Non-fusible safety switches shall have a minimum withstand rating of 10,000A symmetrical. Fusible switch withstand ratings shall apply to non-fused switches when protected by an upstream fuse as listed. Higher withstand ratings allowed by protection of upstream molded case circuit breakers is acceptable when these ratings are documented in manufacturer's UL series combination rating literature, DET-008, or the UL certification directory.

F. Enclosures

1. NEMA 12 enclosures, when furnished, shall be provided without knockouts.

2. NEMA 4/4X enclosures shall be fabricated using 304 stainless steel

2.3 ACCESSORIES

- A. Provide the following accessories where indicated on drawings.
 1. Neutral Kit
 2. Equipment Ground Kit
 3. Auxiliary contacts. Auxiliary contacts shall be designed to open before switch blade contacts part.
 4. Fuse Kit Only (no fuses)
 5. Fuses and Fuse Kit
 6. Crouse Hinds receptacle, interlocked with switch and mating Arcite #APJ48S plug.
 7. Copper Line and Load Lugs

PART 3 - EXECUTION

3.1 GENERAL

- A. In addition to the requirements specified herein, execution shall be in accordance with the requirements of Specification Division 26 and Drawings.

3.2 EXAMINATION

- A. Examine equipment exterior and interior prior to installation. Report any damage and do not install any equipment that is structurally, moisture, or mildew damaged.
- B. The contractor/installer shall make all necessary field measurements to verify that the safety switches shall fit in the allocated space in full compliance with the minimum required clearances recommended by the manufacturer, specified in National Electrical Code and/or Canadian Standards Association required by any applicable local/facility constraints. The following examinations shall include but not be limited to the following.
 1. Verify that the field measurements of the switches are the same as shown on factory drawings.
 2. Inspect the safety switches and confirm that they are ready to be installed.

3. Check walls or the mounting structure for uniformity and a level plumb surface.
 4. Examine the installation area to assure there is enough clearance to install the safety switches such that it will fit in the allocated space in full compliance with the minimum required clearances recommended by the manufacturer, specified in National Electrical Code and required by any applicable local/facility constraints.
 5. Confirm that required utilities are available, in proper location and ready for use.
- C. Commencement of installation means that the contractor/installer accepts these conditions.

3.3 LOCATION

- A. Refer to the projects site layout drawings for details regarding the proper area to place the safety switches.

3.4 INSTALLATION

- A. The contractor/installer shall furnish and completely install the low voltage safety switches as shown on the project drawings. All necessary hardware to secure the switches in place shall be provided by the contractor/installer.
- B. The contractor/installer shall provide and install any required safety labels and identification labels.
- C. The contractor/installer shall mount the safety switch in full compliance with NEC 404.8(A). The center handle shall not be more than 6'7" above the floor or working platform. The contractor/installer shall also verify any minimum ground clearance that is required.
- D. The contractor/installer shall be responsible for procuring and installing any required fuses for fusible safety switches according to the manufacturer's instructions.

3.5 FIELD QUALITY CONTROL

- A. The following quality control checks shall be performed by the contractor/installer.
 1. Inspect the installed safety switches for proper anchoring, alignment and grounding as well as inspecting for any internal and external physical damage.
 2. Confirm that all shipping and packing material has been removed.

3. Check the tightness of all accessible mechanical and electrical connections with a calibrated torque wrench. The minimum acceptable values are specified in the manufacturer's instructions.
4. Check each electrical connection for proper phasing and identification.
5. With power off, check each switch for proper mechanical operation, preferable with the door open (using the interlock defeat to operate the switch), and confirm the continuity of each pole by visual movement of the blade and continuity tester. Confirm the continuity of all installed fuses.
6. With the door closed confirm the door will not open with the switch is in the ON position.

3.6 CLEANING

- A. The contractor/installer shall clean the interior and exterior of the safety switches to remove construction debris, dirt, and shipping materials.
- B. The contractor/installer shall perform minor touch-up on scratched or marred exterior surfaces to match original finish using an approved paint.

END OF SECTION

SECTION 262923

VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.1 SUMMARY

- A. This specification provides the requirements for an adjustable frequency drive, herein referred to as drive, factory integrated with branch circuit protection, power circuit components, control components and door mounted operator devices into an enclosure, herein referred to as drive panel, for variable torque fan and pump applications or for constant torque or fan and pump applications.
- B. RELATED SECTIONS
 - 1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
 - 2. Division 26 Section "Common Work Results for Electrical".

1.2 REFERENCES

- A. The equipment in this specification is designed and manufactured according to latest revision of the following standards (unless otherwise noted).
 - 1. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC)
 - 2. UL 50 – UL Standard for Safety for Enclosures for Electrical Equipment
 - 3. UL 508C – UL Standard for Safety for Power Conversion Equipment
 - 4. UL 508A – UL Standard for Safety for Industrial Control Panels
 - 5. NEMA 250 – Enclosures for Electrical Equipment (1000 Volts Maximum)
 - 6. NEMA – Application Guide For AC Adjustable Speed Drive Systems
 - 7. NEMA ICS 7.1 – Safety Standards for Construction and Guide for Selection, Installation and Operation of Adjustable Speed Drive Systems

1.3 SUBMITTALS

- A. Submit sufficient information to determine compliance with the Contract Documents. Identify submittal data with the specific equipment tags and/or service descriptions to which they pertain. Submittal data shall be clearly marked to identify the specific model numbers, options, and features of equipment and work proposed.
- B. Deviations from the Contract Documents shall be indicated within the submittal. Each deviation shall reference the corresponding drawing or specification number, show the Contract Document requirement text and/or illustration, and shall be accompanied by a detailed written justification for the deviation.
- C. A submittal package shall be furnished to the Engineer for approval prior to factory assembly of the drive. The submittal package shall consist of the following:
 - 1. Elementary diagrams showing factory power and control wiring along with field wiring connections for line and load power connections and control wiring connections.
 - 2. Outline diagrams showing the overall enclosure and mounting dimensions with front and side views and weights as a minimum. The outline drawings shall also include conduit entry/exit locations along with intended conduit sizes.
 - 3. Voltage, horsepower, current rating, and product features will be furnished from standard catalog sheets.
 - 4. Based on supplied details, estimated harmonic calculations shall be provided.
- D. Provide a guarantee against defective materials and workmanship in accordance with requirements of the Section 260500 of these Specifications.

1.4 INSTALLATION, OPERATION AND MAINTENANCE DATA

- A. Manufacturer shall provide a copy of installation, operation, and maintenance procedures to owner.
- B. Instruction manual shall include programming manuals, wiring diagrams, and operating and maintenance instructions.

1.5 QUALITY ASSURANCE

- A. Manufacturer shall have specialized in the manufacture and assembly of low voltage controls for 25 years.
- B. Low voltage drives shall be listed and/or classified by Underwriters Laboratories in accordance with standards listed in Article 1.03 of this specification.

- C. All drives shall be 100% factory tested to ensure proper performance.
- D. All drives are insulation tested (i.e., Hi-pot) at their input and output terminal connections.
- E. All drives are load tested at > 100% of their nominal operating current at assorted speed references.
- F. All drive panels will be functionally tested to ensure proper operation.

1.6 DELIVERY, STORAGE and HANDLING

- A. Contractor shall store, protect, and handle products in accordance with recommended practices listed in manufacturer's Installation and Maintenance Manuals.
- B. Contractor shall inspect and report concealed damage to carrier within 48 hours.
- C. Contractor shall store in a clean, dry space. Cover with heavy canvas or plastic to keep out dirt, water, construction debris and traffic. Heat enclosures to prevent condensation.
- D. Contractor shall install in accordance with manufacturer's recommendations to avoid damaging equipment, installed devices and finish.

1.7 PROJECT CONDITIONS (SITE ENVIRONMENTAL CONDITIONS)

- A. Follow (standards) service conditions before, during and after installation.
- B. Equipment shall be located in well ventilated areas, free from excess humidity, dust and dirt, and away from hazardous materials. Indoor locations shall be protected to prevent moisture from entering enclosure.
- C. The drive panel shall be designed to operate in an ambient temperature range from 0°C to 40°C.
- D. Storage temperatures shall be between -25°C to 65°C.
- E. The drive panel shall be suitable for operation at altitudes up to 3,000 feet without de-rating.

1.8 WARRANTY

- A. The manufacturer warrants the materials and workmanship of the drive to be free from defect for a period of thirty-six (36) months from date of shipment.

1.9 FIELD MEASUREMENTS

- A. Contractor shall make all necessary field measurements to verify that equipment shall fit in allocated space in full compliance with minimum required clearances specified in National Electrical Code.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

2.2 ABB products have been used as the basis of design for variable frequency drives. Approved manufacturers listed below are allowed on condition of meeting the specified conditions including the available space for the equipment (including NEC required working clearances).

- A. ABB, Danfoss or engineer pre-approved equal

2.3 ELECTRICAL RATINGS

- A. Provide equipment rated as indicated on drawings or as specified below.
- B. The drive shall be sized for constant torque (CT) applications with the ability to be applied to variable torque loads.
- C. Input voltage ratings shall be 460VAC +/-10%.
- D. Input frequency shall be 60Hz +/-5%.
- E. The drive panel will have a fault withstand rating of 65k AIC for breaker disconnect style devices.
- F. Displacement power factor of the drive shall be 0.98 lagging or higher.
- G. Drive efficiency at rated load shall be 98% or higher.
- H. The drive panel output current ratings shall be capable continuous operation at a minimum of 100% rated motor full-load current in accordance with NEC Table 430.150.
- I. The CT drive shall provide overload current capacity not less than 150% for 60 seconds.
- J. Output voltage shall be programmable for a motor rating of 480VAC with the actual maximum output voltage equal to the input voltage.

2.4 DESCRIPTION

- A. Refer to Contract Drawings for actual layout and location of equipment and components; current ratings of devices, bus bars and components; voltage ratings of devices, components and assemblies; interrupting and withstand ratings of devices, buses and components; and other required details. Furnish ABB ACQ580, Danfoss or engineer pre-approved equal.
- B. Regulator technology shall be software configurable to either V/Hz or Vector control.
- C. The drive shall use a fix voltage and frequency AC line to generate an adjustable voltage and frequency to control the motor.
- D. The drive will convert the AC mains to a fixed DC voltage using full wave bridge diode or IGBT rectifiers.
- E. The drive will use power semiconductors (IGBTs) to change the fixed DC voltage to an adjustable voltage and frequency to control the motor. The drive shall be an IGBT based PWM type AC drive capable of operating a squirrel cage induction motor with a full load current equal to or less than the continuous output rating of the drive.
- F. All drive panels and enclosures will meet UL508A and will be UL / cUL listed.
- G. The drive panel shall include a fused input disconnect with a through-the-door handle interlocked to the enclosure door to provide a local and lockable means of removing all AC input power from the drive panel.
- H. Branch circuit protection fuses shall be provided to protect the drive. Fuses shall be sized to provide proper branch circuit protection and be coordinated with other power circuit components.
- I. The drive panel shall be a NEMA Type 12 enclosure.
- J. The drive panel will include door mounted operator devices and keypad to facilitate programming, control functions, and diagnostics.
- K. The drive shall have an EMC / RFI filter meeting A2 standards.
- L. The drive shall include an integrated DC Link reactor equivalent to 5% AC impedance or equivalent input line reactor.
- M. A dV/dt filter shall be installed on all motor cable lengths over 50 feet.
- N. The drive panel will include a drive input contactor. To disconnect the drive when the blower is not in operation.

2.5 PROTECTIVE FEATURES

- A. The drive shall provide protection against phase to phase and phase to ground short circuits.
- B. The drive shall monitor and protect against adverse drive thermal conditions.
- C. The drive will include automatic motor overload de-rate functionality to prevent motor thermal overloads.
- D. The drive shall provide for programming up to 4 Skip Frequencies with a user defined bandwidth.
- E. The drive shall protect against internal memory and CPU errors and internal and serial communication errors.
- F. Drive panels with bypass shall contain an adjustable Class 20 ambient compensated overload relay. The overload relay shall provide single-phase protection, visible trip indication, selectable manual/automatic reset and trip test.

2.6 FEATURES AND ADJUSTMENTS

- A. In addition to programmable motor characteristics, the drive shall contain a motor ID run feature that determines the connected motor characteristics to optimize operation.
- B. The drive shall be capable of multiple ramp rates. Each acceleration and deceleration rate shall be independently adjustable from 0.01 to 3600 seconds.
- C. The drive shall record and store in its memory run status and fault type of the past 10 faults for diagnostic assistance. For the two most recent faults, the drive will record at the time of trip the motor input volts, amps, frequency, speed reference, DC bus voltage date and time of fault.
- D. The drive shall be capable of starting into a rotating load (forward or reverse) and shall smoothly accelerate or decelerate to the speed reference set point without experiencing the drive tripping on a fault or a component failure.
- E. The drive shall be capable of automatically resetting low level faults with multiple programmable restart attempts at timed intervals.
- F. The drive shall contain a selectable energy savings function that, when selected, automatically reduces the drive output voltage at steady state operation to the level only required to meet the torque requirement of the load.
- G. The drive will track and display Running Hours.

- H. The drive shall have a programmable Start Delay function with an adjustable holding time from 0.0-120.0 seconds. The motor start will be delayed by the amount of time selected.
- I. The drive shall have both low and high frequency limits programmable from 0 to the drive's maximum output frequency.
- J. The drive shall accept and follow a selectable external analog speed reference of 4-20mA with signal inversion.
- K. The drive shall provide an adjustable 4-20mA analog output signal.

2.7 OPERATOR CONTROLS

- A. The drive's control power for digital inputs will be 24VDC.
- B. The drive panel shall have a control terminal strip for field I/O wiring.
- C. The drive will include 6 programmable digital inputs.
- D. The drive will include 3 programmable relay outputs.
- E. The drive will include 2 programmable and scalable analog inputs and outputs.
- F. All drive panel door mounted operators will be 30mm industrial rated devices. All Pilot lights shall be PTT LED type.
- G. Operator controls and indicating devices shall include Drive Keypad, Power On Light, Hand-Off-Auto Switch, Drive Run and Fault Lights, and Elapsed Time Meter.

2.8 KEYPAD INTERFACE

- A. The drive shall contain a backlit graphic alpha-numeric liquid crystal display (LCD) display for programming, diagnostics, I/O check, operation status and copy functions. The LCD display shall function independently of the programming mode to allow programming and monitoring of the drive simultaneously.
- B. The keypad shall be common for the entire horsepower and input voltage ratings and shall be capable of copying (uploading and downloading) drive parameters between the different horsepower and voltage ratings.
- C. The drive keypad will include help functions for integrated parameter and diagnostic assistance.
- D. The drive keypad allows for 2 levels of password protection with independent password.

2.9 NETWORK COMMUNICATIONS

- A. The drive shall include MODBUS RTU, and Ethernet IP communication protocols.
- B. It should be possible to start/stop the drive and send a speed reference through Ethernet/IP. A register listing containing pertinent data points should be provided to the system integrator for mapping purposes. This listing should display status conditions for bits (e.g., BIT ON = Running, BIT OFF = Stopped) and analog value scaling (e.g., RAW COUNTS = 0 – 10000, ENGINEERING UNITS = 0 – 100.00 %).

PART 3 - EXECUTION

3.1 EXAMINATION

- A. The contractor shall perform the following procedures:
 - 1. Examine installation area to assure there is enough clearance to install panel.
 - 2. Check concrete pads and mounting surfaces for uniformity and level surface.
 - 3. Inspect for any physical damage.
 - 4. Verify that equipment is ready to install.
 - 5. Verify field measurements are as instructed by manufacturer.
 - 6. Verify that required utilities and control interfaces are available, in proper location and ready for use.

3.2 LOCATION AND INSTALLATION

- A. The contractor shall perform the installation.
 - 1. The contractor shall install drives in accordance with standards listed in Article 1.2 of this specification.
 - 2. Install per manufacturer's instructions outlined in installation, operation, and maintenance documentation.

3.3 START-UP AND TRAINING

- A. Manufacturer shall have Factory Trained and authorized personnel at Field locations convenient to the installation site, available for Troubleshooting and/or Start-Up assistance.

- B. Drive operational and maintenance Training and/or Start-Up Service shall be provided by a factory trained and authorized individual.

END OF SECTION

SECTION 263213

GENERATOR

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide labor, material, equipment, related services, and supervision required, including, but not limited to, manufacturing, fabrication, configuration and installation for the engine-driven generator set as required for the complete performance of the work, as shown on the drawings, as specified herein, and as specified elsewhere for the assemblies or systems comprised of the components specified herein.
- B. RELATED SECTIONS
 - 1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
 - 2. Division 26 Section "Common Work Results for Electrical".
 - 3. Section 26 36 23 Automatic Transfer Switches

1.2 REFERENCES

- A. The engine-driven generator set in this specification are designed and manufactured according to latest revision of the following standards (unless otherwise noted).
 - 1. National Fire Protection Association (NFPA) 70, National Electrical Code (NEC)
 - 2. NFPA 37 Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines
 - 3. NFPA 110 Standard for Emergency and Standby Power Systems.
 - 4. Institute of Electrical and Electronics Engineers (IEEE)
 - 5. National Electrical Manufacturers Association (NEMA)
 - 6. American National Standards Institute (ANSI)
 - 7. EPA Tier Levels for Non-Road Engines

1.3 DEFINITIONS

- A. Emergency Standby Power (ESP): Per ISO 8528: The maximum power available during a variable electrical power sequence, under the stated operating conditions, for which a generating set is capable of delivering in the event of a utility power outage or under test conditions for up to 200 hours of operation per year with the maintenance intervals and procedures being carried out as prescribed by the manufacturers. The permissible average power output (Ppp) over 24 hours of operation shall not exceed 70 percent of the ESP unless otherwise agreed by the RIC engine manufacturer.
- B. Prime Power (PRP): Per ISO 8528: The maximum power which a generating set is capable of delivering continuously whilst supplying a variable electrical load when operated for an unlimited number of hours per year under the agreed operating conditions with the maintenance intervals and procedures being carried out as a prescribed by the manufacturer. The permissible average power output (Ppp) over 24 hours of operation shall not exceed 70 percent of the PRP unless otherwise agreed by the RIC engine manufacturer.
- C. Limited Time running Power (LTP): Per ISO 8528: The maximum power available, under the agreed operating conditions, for which the generating set is capable of delivering for up to 500 hours of operation per year with the maintenance intervals and procedures being carried out as prescribed by the manufacturers.
- D. Continuous Operating Power (COP): Per ISO 8528: The maximum power which a generating set is capable of delivering continuously whilst supplying a constant electrical load when operated for an unlimited number of hours per year under the agreed operating conditions with the maintenance intervals and procedures being carried out as a prescribed by the manufacturer.
- E. Data Center Continuous (DCC): The maximum power which a generating set is capable of delivering continuously whilst supplying a variable or constant electrical load when operated for an unlimited number of hours in a data center application under the agreed operating conditions with the maintenance intervals and procedures being carried out as a prescribed by the manufacturer. The permissible average power output (Ppp) over 24 hours of operation shall not exceed 100 percent of the DCC rating.
- F. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of packaged engine generator indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. In addition, include the following:

1. Thermal damage curve for generator.
 2. Time-current characteristic curves for generator protective device.
 3. Sound test data, based on a free field requirement.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, and location and size of each field connection.
1. Dimensioned outline plan and elevation drawings of engine-generator set and other components specified.
 2. Wiring Diagrams: Control interconnection, Customer connections.
- C. Certifications:
1. Submit statement of compliance which states the proposed product(s) is certified to the emissions standards required by the location for No Preference.
 2. Submit statement of compliance which states the proposed product(s) are seismically certified in compliance with local requirements signed and sealed by a qualified professional engineer.
 3. Product(s) shall be preapproved for California's Office of Statewide Health Planning and Development (OSHPD) seismic certification of equipment. Justification for preapproval shall be based on calculations as well as physical dynamic testing.

1.5 INFORMATIONAL SUBMITTALS

- A. Manufacturer Seismic Qualification Certification: Submit certification that the 1000 Gallons fuel tank, the Sound Attenuated enclosure, engine-generator set, and components will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems." Include the following:
1. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 2. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- B. Source quality-control test reports.
1. Certified summary of prototype-unit test report. See requirements in Part 2 "Source Quality Control" Article Part A. Include statement indicating torsional compatibility of components.

2. Certified Test Report: Provide certified test report documenting factory test per the requirements of this specification, as well as certified factory test of generator set sensors per NFPA110 level 1.
 3. List of factory tests to be performed on units to be shipped for this Project.
 4. Report of exhaust emissions and compliance statement certifying compliance with applicable regulations.
- C. Warranty:
1. Submit manufacturer's warranty statement to be provided for this Project.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
- B. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 4 miles of Project site, a service center capable of providing training, parts, and emergency maintenance repairs.
- C. Source Limitations: Obtain packaged generator sets and auxiliary components through one source from a single manufacturer.
- D. Comply with NFPA 37 (Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines).
- E. Comply with NFPA 70 (National Electrical Code. Equipment shall be suitable for use in systems in compliance to Article 700, 701, and 702).
- F. Comply with NFPA 99 (Essential Electrical Systems for Health Care Facilities).
- G. Comply with NFPA 110 (Emergency and Standby Power Systems) requirements for Level 1 emergency power supply system.
- H. Comply with applicable Institute of Electrical and Electronics Engineers, Inc. (IEEE) standards pertaining to generator construction.
- I. Comply with UL 2200.
- J. Comply with CSA 22.2.

1.7 PROJECT CONDITIONS

- A. Environmental Conditions: Engine-generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:
 - 1. Ambient Temperature: 32.0 deg F to 113.0 deg F.
 - 2. Relative Humidity: 0 to 95 percent.
 - 3. Altitude: Sea level to 150.0 feet.

1.8 WARRANTY

- A. Manufacturer shall provide base warranty coverage on the material and workmanship of the generator set for a minimum of twenty-four (24) months for Standby product and twelve (12) months for Prime/Continuous product from registered commissioning and start-up.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. The basis for this specification is Cummins Power Generation equipment. Other manufactures' products of equivalent quality, dimensions and operating features may be acceptable, at the Engineer's discretion, if they comply with all requirements specified.
- B. Other pre-approved manufacturers.
 - 1. Caterpillar
 - 2. Kohler
 - 3. IGSA Power

2.2 ENGINE-GENERATOR SET

- A. Factory-assembled and -tested, engine-generator set.
- B. Mounting Frame: Maintain alignment of mounted components without depending on concrete foundation; and have lifting attachments.
 - 1. Rigging Information: Indicate location of each lifting attachment, generator-set center of gravity, and total package weight in submittal drawings.

C. Capacities and Characteristics:

1. Power Output Ratings: Electrical output power rating for Prime operation of not less than 480.0kW, at 80 percent lagging power factor, 240/416, Series Wye, Three phase, 4 -wire, 60 hertz.
2. Alternator shall be capable of accepting maximum 100.0 kVA in a single step and be capable of recovering to a minimum of 90% of rated no load voltage. Following the application of the specified kVA load at near zero power factor applied to the generator set.
3. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component. The engine-generator nameplate shall include information of the power output rating of the equipment.

D. Generator-Set Performance:

1. Steady-State Voltage Operational Bandwidth: 0.5 percent of rated output voltage from no load to full load.
2. Transient Voltage Performance: Not more than 20 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within 5 seconds. On application of a 100% load step the generator set shall recover to stable voltage within 10 seconds.
3. Steady-State Frequency Operational Bandwidth: 0.25 percent of rated frequency from no load to full load.
4. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
5. Transient Frequency Performance: Not more than 15 percent variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within 5 seconds. On application of a 100% load step the generator set shall recover to stable frequency within 10 seconds.
6. Output Waveform: At full load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for any single harmonic. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50.
7. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 300 percent of rated full-load current for not less than 8 seconds without damage to generator system components. For a 1-phase, bolted short circuit at system output terminals,

system shall regulate both voltage and current to prevent over-voltage conditions on the non-faulted phases.

8. Start Time: Comply with NFPA 110, Level 1, Type 10, system requirements.
9. Ambient Condition Performance: Engine generator shall be designed to allow operation at full rated load in an ambient temperature under site conditions, based on highest ambient condition. Ambient temperature shall be as measured at the air inlet to the engine generator for enclosed units, and at the control of the engine generator for machines installed in equipment rooms.
10. Noise Output: Engine generator shall be tested by the manufacturer per ANSI S12.34. Data documenting performance shall be provided with submittal documentation.
11. Load Sharing: Engine generator shall share real and reactive load proportionally within plus or minus 3 percent with all other engine generators in the system.

2.3 ENGINE

- A. Fuel: ASTM D975 #2 Diesel Fuel
- B. Rated Engine Speed: 1500RPM.
- C. Lubrication System: The following items are mounted on engine or skid:
 1. Lube oil pump: shall be positive displacement, mechanical, full pressure pump.
 2. Filter and Strainer: Provided by the engine manufacturer of record to provide adequate filtration for the prime mover to be used.
 3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.
- D. Engine Fuel System: The engine fuel system shall be installed in strict compliance to the engine manufacturer's instructions
- E. Main Fuel Pump: Mounted on engine. Pump ensures adequate primary fuel flow under starting and load conditions.
- F. Coolant Jacket Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity and performance.
 1. Designed for operation on a single 240 VAC, Three phase, 50Hz power connection. Heater voltage shall be shown on the project drawings.

2. Installed with isolation valves to isolate the heater for replacement of the element without draining the engine cooling system or significant coolant loss.
 3. Provided with a 24VDC thermostat, installed at the engine thermostat housing
- G. Governor: Adjustable isochronous, with speed sensing. The governing system dynamic capabilities shall be controlled as a function of engine coolant temperature to provide fast, stable operation at varying engine operating temperature conditions. The control system shall actively control the fuel rate as appropriate to the state of the engine generator. Fuel rate shall be regulated as a function of starting, accelerating to start disconnect speed, accelerating to rated speed, and operating in various isochronous states.
- H. Cooling System: Closed loop, liquid cooled
1. The generator set manufacturer shall provide prototype test data for the specific hardware proposed demonstrating that the machine will operate at rated standby load in an outdoor ambient condition of 40 deg C.
 2. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
 3. Size of Radiator overflow tank: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
 4. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.
 5. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
 6. Duct Flange: Generator sets installed indoors shall be provided with a flexible radiator duct adapter flange.
- I. Muffler/Silencer: Selected with performance as required to meet sound requirements of the application, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements. For generator sets with outdoor enclosures the silencer shall be inside the enclosure.
- J. Air-Intake Filter: Engine-mounted air cleaner with replaceable dry-filter element and restriction indicator.
- K. Starting System: 12 or 24V, as recommended by the engine manufacturer; electric, with negative ground.

1. Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified in Part 1 "Project Conditions" Article.
2. Cranking Cycle: As required by NFPA 110 for level 1 systems.
3. Battery Cable: Size as recommended by engine manufacturer for cable length as required. Include required interconnecting conductors and connection accessories.
4. Battery Compartment: Factory fabricated of metal with acid-resistant finish.
5. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation. The battery charging alternator shall have sufficient capacity to recharge the batteries with all parasitic loads connected within 4 hours after a normal engine starting sequence.
6. Battery Chargers: Unit shall comply with UL 1236, provide fully regulated, constant voltage, current limited, battery charger for each battery bank. It will include the following features:
 - a. Operation: Equalizing-charging rate based on generator set manufacturer's recommendations shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.
 - b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 20 deg C to plus 40 deg C to prevent overcharging at high temperatures and undercharging at low temperatures.
 - c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.
 - d. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.
 - e. Provide LED indication of general charger condition, including charging, faults, and modes. Provide a LCD display to indicate charge rate and battery voltage. Charger shall provide relay contacts for fault conditions as required by NFPA110.

- f. Enclosure and Mounting: NEMA, Type 1, wall-mounted cabinet.

2.4 FUEL OIL STORAGE

- A. Comply with NFPA 30.
- B. Day Tank (INDOOR or LOCATED IN HOUSING): Comply with UL 142, UL 2085, CSA, freestanding, factory-fabricated fuel tank assembly, with integral, float-controlled transfer pump and the following features:
 - 1. Allocation: A separate day tank shall be provided for each engine generator
 - 2. Containment: Integral rupture basin with a capacity of 150 percent of nominal capacity of day tank.
 - a. Leak Detector: Locate in rupture basin and connect to provide audible and visual alarm in the event of day-tank leak.
 - 3. Tank Capacity: 1500 Gallons
 - 4. Pump Capacity: Minimum 2 GPM with 20 foot lift, driven by ¼ HP, 120/240V 1-phase motor.
 - 5. Control: Provided with On/Off/Emergency run switch, Test/Reset Switch, AC Circuit Breaker, DC Circuit Breaker, and the following indicator lamps:
 - a. Ready (Green) – AC Supply and DC Control Power Available.
 - b. High Fuel (Red) – Latching fault, indicates fuel level near overflow, shuts down pump, and closes N/O dry contacts.
 - c. Low Fuel (Red) – Latching fault, indicates pump failure or operating float switch failure, closes N/O dry contacts.
 - d. Low Fuel Shutdown (Red) – Latching fault, indicates near empty tank, closes N/O contacts which may be used to shutdown engine generator to avoid air in the injection system.
 - e. Overflow To Basin (Red) – Latching fault, indicates fuel in overflow/rupture basin, shuts down pump, closes N/O dry contacts
 - f. Spare (Red) – with N/O and N/C dry contacts
 - g. Pump Running (Green)
 - 6. Piping Connections: Factory-installed fuel supply and return lines from tank to engine; local fuel fill, and vent lines in compliance with local code requirements.

- C. Sub Base-Mounted Fuel Oil Tank: Provide a double wall secondary containment type sub base fuel storage tank. The tank shall be constructed of corrosion resistant steel and shall be UL 142, UL 2085, CSA listed and labeled. The fuel tank shall include the following features:
1. Capacity: 1000 Gallons
 2. Tank rails and lifting eyes shall be rated for the full dry weight of the tank, genset, and enclosure.
 3. Electrical stub up(s)
 4. Normal & emergency vents
 5. Lockable fuel fill
 6. Mechanical fuel level gauge
 7. High and low level switches to indicate fuel level
 8. Leak detector switch
 9. Sub base tank shall include a welded steel containment basin, sized at a minimum of 130% of the tank capacity to prevent escape of fuel into the environment in the event of a tank rupture.
 10. Fill port with overfill prevention valve (OFPV)
 11. 5 gallon fill/spill dam or bucket
 12. Tank design shall meet the regional requirements for the Project location

2.5 CONTROL AND MONITORING

- A. Engine generator control shall be microprocessor based and provide automatic starting, monitoring, protection and control functions for the unit.
- B. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of generator set. When mode-selector switch is switched to the on position, generator set starts. The off position of same switch initiates generator-set shutdown. (Switches with different configurations but equal functions are acceptable.) When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of the local (generator set-mounted) and/or remote emergency-stop switch also shuts down generator set.

- C. Manual Starting System Sequence of Operation: Switching on-off switch on the generator control panel to the on position starts generator set. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of the local (generator set-mounted) and/or remote emergency-stop switch also shuts down generator set.
- D. Configuration: Operating and safety indications, protective devices, system controls, engine gages and associated equipment shall be grouped in a common control and monitoring panel. Mounting method shall isolate the control panel from generator-set vibration. AC output power circuit breakers and other output power equipment shall not be mounted in the control enclosure.
- E. Indicating and Protective Devices and Controls: As required by NFPA 110 for Level 1 system, and the following:
 - 1. AC voltmeter (3-phase, line to line and line to neutral values).
 - 2. AC ammeter (3-phases).
 - 3. AC frequency meter.
 - 4. AC kW output (total and for each phase). Display shall indicate power flow direction.
 - 5. AC kVA output (total and for each phase). Display shall indicate power flow direction.
 - 6. AC Power factor (total and for each phase). Display shall indicate leading or lagging condition.
 - 7. Ammeter-voltmeter displays shall simultaneously display conditions for all three phases.
 - 8. Emergency Stop Switch: Switch shall be a red “mushroom head” pushbutton device complete with lock-out/tag-out provisions. Depressing switch shall cause the generator set to immediately stop the generator set and prevent it from operating.
 - 9. Fault Reset Switch: Supply a dedicated control switch to reset/clear fault conditions.
 - 10. DC voltmeter (alternator battery charging).
 - 11. Engine-coolant temperature gauge.
 - 12. Engine lubricating-oil pressure gauge.

13. Running-time meter.
 14. Generator-voltage and frequency digital raise/lower switches. Rheostats for these functions are not acceptable. The control shall adjustment of these parameters in a range of plus or minus 5% of the voltage and frequency operating set point (not nominal voltage and frequency values.) The voltage and frequency adjustment functions shall be disabled when the paralleling breaker is closed.
 15. Fuel tank derangement alarm.
 16. Fuel tank high-level shutdown of fuel supply alarm.
 17. AC Protective Equipment: The control system shall include over/under voltage, reverse kVAR, reverse kW, over load (kW) short circuit, over current, loss of voltage reference, and over excitation shut down protection. There shall be a ground fault alarm for generator sets rated over 1000 amps, overload warning, and overcurrent warning alarm.
 18. Status LED indicating lamps to indicate remote start signal present at the control, existing shutdown condition, existing alarm condition, not in auto, and generator set running.
 19. A graphical display panel with appropriate navigation devices shall be provided to view all information noted above, as well as all engine status and alarm/shutdown conditions (including those from an integrated engine emission control system). The display shall also include integrated provisions for adjustment of the gain and stability settings for the governing and voltage regulation systems.
 20. Panel lighting system to allow viewing and operation of the control when the generator room or enclosure is not lighted.
 21. Data Logging: The control system shall log the latest 20 different alarm and shut down conditions, the total number of times each alarm or shutdown has occurred, and the date and time the latest of these shutdown and fault conditions occurred.
 22. DC control Power Monitoring: The control system shall continuously monitor DC power supply to the control, and annunciate low or high voltage conditions. It shall also provide an alarm indicating imminent failure of the battery bank based on degraded voltage recover on loading (engine cranking).
 23. Paralleling Breaker control switches: The control shall include manual open and close provisions for the paralleling breaker, and LED status lamps indicating whether the breaker is open or closed.
- F. Control Heater: Generator sets that are installed in outdoor enclosures, or are in tropical or coastal environments shall be provided with control heaters for anti-condensation protection.

- G. Common Remote Audible Alarm: Comply with NFPA 110 requirements for Level 1 systems. Include necessary contacts and terminals in control and monitoring panel.
 - 1. Overcrank shutdown.
 - 2. Coolant low-temperature alarm.
 - 3. Control switch not in auto position.
 - 4. Battery-charger malfunction alarm.
 - 5. Battery low-voltage alarm.
- H. Remote Alarm Annunciator: Comply with NFPA 110. An LED labeled with proper alarm conditions shall identify each alarm event and a common audible signal shall sound for each alarm condition.
- I. Remote Emergency-Stop Switch: Flush; wall mounted, unless otherwise indicated; and labeled. Push button shall be protected from accidental operation.
- J.

2.6 GENERATOR OVERCURRENT AND FAULT PROTECTION

- A. Generator Overcurrent Protection: The generator set shall be provided with a UL Listed/CSA Certified protective device that is coordinated with the alternator provided to prevent damage to the generator set on any possible overload or overcurrent condition external to the machine. The protective device shall be listed as a utility grade protective device under UL category NRGU. The control system shall be subject to UL follow-up service at the manufacturing location to verify that the protective system is fully operational as manufactured. Protector shall perform the following functions:
 - 1. Initiates a generator kW overload alarm when generator has operated at an overload equivalent to 110 percent of full-rated load for 60 seconds. Indication for this alarm is integrated with other generator-set malfunction alarms.
 - 2. Under single phase or multiple phase fault conditions, or on overload conditions, indicates an alarm conditions when the current flow is in excess of 110% of rated current for more than 10 seconds.
 - 3. Under single phase or multiple phase fault conditions, operates to switch off alternator excitation at the appropriate time to prevent damage to the alternator.
 - 4. The operator panel shall indicate the nature of the fault condition as either a short circuit or an overload.

5. Senses clearing of a fault by other overcurrent devices and controls recovery of rated voltage to avoid overshoot greater than 120% of nominal voltage.
 6. The protective system provided shall not include an instantaneous trip function.
- B. Ground-Fault Indication: Comply with NFPA 70, "Emergency System" signals for ground-fault. Integrate ground-fault alarm indication with other generator-set alarm indications.

2.7 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

- A. Comply with NEMA MG 1.
- B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.
- C. Electrical Insulation: Class H
- D. Temperature Rise: 120C / Class H environment.
- E. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, over speed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.
- F. Permanent Magnet Generator (PMG) shall provide excitation power for optimum motor starting and short circuit performance.
- G. Enclosure: Drip-proof.
- H. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified. The voltage regulation system shall be microprocessor-controlled, 3-phase true RMS sensing, full wave rectified, and provide a pulse-width modulated signal to the exciter. No exceptions or deviations to these requirements will be permitted.
- I. The alternator shall be provided with anti-condensation heater(s) in all applications where the generator set is provided in an outdoor enclosure, or when the generator set is installed in a coastal or tropical environment.
- J. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding. Alternators operating at voltage higher than 690VAC shall be provided with form-wound stator coils.
- K. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.
- L. Subtransient Reactance: 12 percent maximum, based on the rating of the engine generator set.

2.8 OUTDOOR GENERATOR-SET ENCLOSURE

- A. Description: Sound Attenuated Steel housing. Multiple panels shall be lockable and provide adequate access to components requiring maintenance. Instruments, control, and battery system shall be mounted within enclosure.
- B. Construction:
1. Louvers: Equipped with bird screen to permit air circulation when engine is not running while excluding birds and rodents.
 2. Hinged Doors: With padlocking provisions. Restraint/Hold back hardware to prevent door to keep door open at 180 degrees during maintenance. Rain lips over all doors.
 3. Exhaust System:
 - a. Muffler Location: Within enclosure.
 4. Hardware: All hardware and hinges shall be stainless steel.
 5. Wind Rating: Wind rating shall be 150 mph
 6. Mounting Base: Suitable for mounting on sub-base fuel tank or housekeeping pad.
 7. A weather protective enclosure shall be provided which allows the generator set to operate at full rated load with a static pressure drop equal to or less than 0.5 inches of water.
 8. Inlet ducts shall include rain hoods
- C. Engine Cooling Airflow through Enclosure: Housing shall provide ample airflow for engine generator operation at rated load in an ambient temperature of 40 deg C.
1. Louvers: Fixed-engine, cooling-air inlet and discharge.
 2. Motorized Louvers: At engine cooling-air inlet and discharge. Dampers shall be closed to reduce enclosure heat loss in cold weather when unit is not operating. Dampers shall be of a “fail open” design to allow airflow in the event of failure
- D. Sound Performance: Reduce the sound level of the engine generator while operating at full rated load to a maximum of 7 dBA measured at any location 10 m from the engine generator in a free field environment.
- E. Electrical Provisions
1. Compliance with NEC: Package shall comply with the requirements of the National Electrical Code for all wiring materials and component spacing.

2. Provide an internally mounted and wired electrical distribution panel to serve the engine generator and enclosure; including:
 - a. 100 amp distribution panelboard connected to a 120/240VAC utility service by the installer.
 - b. Two duplex GFI receptacles, one inside the enclosure, and a weatherproof receptacle on the outside of the enclosure.
 - c. Factory wired normal AC service from the panelboard to the engine coolant heater, alternator heater, and battery charger.
 - d. Interior Lights with Switch: Two three-way switches controlling three AC lamps mounted in vapor tight and gasketed fixtures
3. External Electrical Connections: All power and control interconnections shall be made within the perimeter of the enclosure.

F. Site Provisions:

1. Lifting: Complete assembly of engine generator, enclosure, and sub base fuel tank (when used) shall be designed to be lifted into place as a single unit, using spreader bars.

2.9 VIBRATION ISOLATION DEVICES

- A. Vibration Isolation: Generators installed on grade shall be provided with elastomeric isolator pads integral to the generator, unless the engine manufacturer requires use of spring isolation.
 1. IBC Compliance: Isolators complying with IBC requirements shall be specified in the equipment documentation, as well as the installation requirements for the unit.

2.10 FINISHES

- A. Indoor and Outdoor Enclosures and Components: Powder-coated and baked over corrosion-resistant pretreatment and compatible primer. Manufacturer's standard color or as directed on the drawings.

2.11 SOURCE QUALITY CONTROL

- A. Prototype Testing: Factory test engine-generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.

1. Tests: Comply with NFPA 110, Level 1 Energy Converters. In addition, the equipment engine, skid, cooling system, and alternator shall have been subjected to actual prototype tests to validate the capability of the design under the abnormal conditions noted in NFPA110. Calculations and testing on similar equipment which are allowed under NFPA110 are not sufficient to meet this requirement.
- B. Project-Specific Equipment Tests: Before shipment, factory test engine-generator set manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:
1. Test engine generator set manufactured for this Project to demonstrate compatibility and functionality.
 2. Full load run.
 3. Maximum power.
 4. Voltage regulation.
 5. Steady-state governing.
 6. Single-step load pickup.
 7. Simulated safety shutdowns.
 8. Provide 14 days' advance notice of tests and opportunity for observation of tests by Owner's representative.
- C. Factory testing may be witnessed by the owner and consulting engineer. Costs for travel expenses will be the responsibility of the owner and consulting engineer. Supplier is responsible to provide two weeks' notice for testing.

PART 3 - EXECUTION

3.1 INSTALLTION

- A. Comply with packaged engine-generator manufacturers' written installation, application, and alignment instructions and with NFPA 110.
- B. Equipment shall be installed by the contractor in accordance with final submittals and contract documents. Installation shall comply with applicable state and local codes as required by the authority having jurisdiction. Install equipment in accordance with manufacturer's instructions and instructions included in the listing or labeling of UL listed products.

- C. Installation of equipment shall include furnishing and installing all interconnecting wiring between all major equipment provided for the on-site power system. The contractor shall also perform interconnecting wiring between equipment sections (when required), under the supervision of the equipment supplier.
- D. Equipment shall be installed on concrete housekeeping pads. Equipment shall be permanently fastened to the pad in accordance with manufacturer's instructions and seismic requirements of the site.
- E. Equipment shall be initially started and operated by representatives of the manufacturer. All protective settings shall be adjusted as instructed by the consulting engineer.
- F. All equipment shall be physically inspected for damage. Scratches and other installation damage shall be repaired prior to final system testing. Equipment shall be thoroughly cleaned to remove all dirt and construction debris prior to initial operation and final testing of the system.
- G. On completion of the installation by the electrical contractor, the generator set supplier shall conduct a site evaluation to verify that the equipment is installed per manufacturer's recommended practice.

3.2 ON-SITE ACCEPTANCE TEST

- A. The complete installation shall be tested to verify compliance with the performance requirements of this specification following completion of all site work. Testing shall be conducted by representatives of the manufacturer, with required fuel supplied by Contractor. The Engineer shall be notified in advance and shall have the option to witness the tests. The generator set manufacturer shall provide a site test specification covering the entire system. Tests shall include:
 - B. Prior to start of active testing, all field connections for wiring, power conductors, and bus bar connections shall be checked for proper tightening torque.
 - C. Installation acceptance tests to be conducted on site shall include a "cold start" test, a two hour full load (resistive) test, and a one-step rated load pickup test in accordance with NFPA 110. Provide a resistive load bank and make temporary connections for full load test, if necessary.
 - D. Perform a power failure test on the entire installed system. This test shall be conducted by opening the power supply from the utility service, and observing proper operation of the system for at least 2 hours. Coordinate timing and obtain approval for start of test with site personnel.

3.3 TRAINING

- A. The equipment supplier shall provide training for the facility operating personnel covering operation and maintenance of the equipment provided. The training program shall be not less than 4 hours in duration and the class size shall be limited to 5 persons. Training date shall be coordinated with the facility owner.

3.4 FIELD QUALITY CONTROLS

- A. **Manufacturer's Field Service:** Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

3.5 SERVICE AND SUPPORT

- A. The generator set supplier shall maintain service parts inventory for the entire power system at a central location which is accessible to the service location 24 hours per day, 365 days per year. The inventory shall have a commercial value of \$3 million or more. The manufacturer of the generator set shall maintain a central parts inventory to support the supplier, covering all the major components of the power system, including engines, alternators, control systems, paralleling electronics, and power transfer equipment.
- B. The generator set shall be serviced by a local service organization that is trained and factory certified in generator set service. The supplier shall maintain an inventory of critical power system replacement parts in the local service location. Service vehicles shall be stocked with critical replacement parts. The service organization shall be on call 24 hours per day, 365 days per year. The service organization shall be physically located within 4 miles of the site.
- C. The manufacturer shall maintain model and serial number records of each generator set provided for at least 20 years.

3.6 SERVICE AGREEMENT

- A. The supplier shall include in the base price, a one-year service agreement. The maintenance shall be performed by factory authorized service technicians capable of servicing both the engine generator set and the transfer switch (es). This agreement shall include the following:
 - 1. Generator supplier must have an in-house rental fleet with equipment sized to back up this project site.
 - 2. All engine maintenance as recommended by the service manual.

3. All electrical controls maintenance and calibrations as recommended by the manufacturer.
4. All auxiliary equipment as a part of the emergency systems.
5. The supplier shall guarantee emergency service.
6. All expendable maintenance items are to be included in this agreement.
7. A copy of this agreement and a schedule shall be given to the Owner at the time of his acceptance, showing what work is to be accomplished and when.

END OF SECTION

SECTION 263623

AUTOMATIC TRANSFER SWITCHES

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish and install automatic delayed transfer switches (3ADTS) with number of poles, amperage, voltage, and withstand current ratings as shown on the plans. Each automatic transfer shall consist of a mechanically held power transfer switch unit and a microprocessor controller, interconnected to provide complete automatic operation. All transfer switches and control panels shall be the product of the same manufacturer.
- B. The 3ADTS shall transfer the load in delayed transition (break – before –make) mode. Transfer is accomplished with a user – defined interruption period in both directions.
- C. The load disconnect time delay shall be configured to be active for all transfers or to be bypassed in the event that the voltage of all three phases of the source the load is connected to drop below 70% of nominal.

1.2 RELATED SECTIONS

- 1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- 2. Division 26 Section "Common Work Results for Electrical".
- 3. Section 26 32 13 Generator

1.3 REFERENCES

- A. The automatic delayed transfer switches and accessories shall conform to the requirements of:
 - 1. UL 1008 - Standard for Automatic Transfer Switches
 - 2. CSA C22.2 No.178 – 1978
 - 3. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC)
 - 4. NFPA 110 - Emergency and Standby Power Systems

5. IEEE Standard 446 - IEEE Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications
6. NEMA Standard ICS10-2005(formerly ICS2-447) - AC Automatic Transfer Switches
7. NEC Articles 700, 701, 702
8. International Standards Organization ISO 9001: 2008
9. IEC 60947-6-1

1.4 SUBMITTALS

- A. Submit sufficient information to determine compliance with the Contract Documents. Identify submittal data with the specific equipment tags and/or service descriptions to which they pertain. Submittal data shall be clearly marked to identify the specific model numbers, options, and features of equipment and work proposed.
- B. Deviations from the Contract Documents shall be indicated within the submittal. Each deviation shall reference the corresponding drawing or specification number, show the Contract Document requirement text and/or illustration, and shall be accompanied by a detailed written justification for the deviation.
- C. Manufacturer shall provide copies of following documents to owner for review and evaluation in accordance with general requirements of Division 1 and Division 26.
 1. Product data on specified product.
 2. Shop drawings on specified product.

1.5 WARRANTY

- A. The manufacturer shall warrant that the ATS will be free from defects in material and workmanship and will conform to the Manufacturer's standard specifications for the ATS for a period of twenty four (24) months from date of product shipment from the manufacturer.

PART 2 - PRODUCTS

2.1 MANUFATURER

- A. ASCO products have been used as the basis for design. Other manufacturers' products of equivalent quality, dimensions and operating features may be acceptable, at the

Engineer's discretion, if they comply with all requirements specified or indicated in these Contract documents. The following equipment shall be provided:

1. ASCO Series 300 (3ADTS).
2. ABB Zenith

2.2 MECHANICALLY HELD TRANSFER SWITCH

- A. The transfer switch unit shall be electrically operated and mechanically held. The electrical operators shall be dual-solenoid mechanisms, momentarily energized. Main operators which include over current disconnect devices will not be accepted. The switch shall be mechanically interlocked to ensure only one of two possible positions, normal or emergency.
- B. The switch shall be positively locked and unaffected by momentary outages so that contact pressure is maintained at a constant value and temperature rise at the contacts is minimized for maximum reliability and operating life.
- C. All main contacts shall be silver composition. Switches rated 800 amperes and above shall have segmented blow-on construction for high withstand current capability and be protected by separate arcing contacts.
- D. Inspection of all contacts shall be possible from the front of the switch without disassembly of operating linkages and without disconnection of power conductors. A manual operating handle shall be provided for maintenance purposes. The handle shall permit the operator to manually stop the contacts at any point throughout their entire travel to inspect and service the contacts when required.
- E. Designs utilizing components of molded-case circuit breakers, contactors, or parts thereof which are not intended for continuous duty, repetitive switching or transfer between two active power sources are not acceptable.
- F. Where neutral conductors must be switched, the ADTS shall be provided with fully- rated neutral transfer contacts.
- G. Where neutral conductors are to be solidly connected, a neutral terminal plate with fully-rated AL-CU pressure connectors shall be provided.

2.3 CONTROLLER

- A. The controller shall be connected to the transfer switch by an interconnecting wiring harness. The harness shall include a keyed disconnect plug to enable the controller to be disconnected from the transfer switch for routine maintenance.

- B. The controller shall direct the operation of the transfer switch. The controller's sensing and logic shall be controlled by a built-in microprocessor for maximum reliability, minimum maintenance, inherent serial communications capability, and the ability to communicate via the Ethernet through optional communications module
- C. A single controller shall provide single and three phase capability for maximum application flexibility and minimal spare part requirements. Voltage sensing shall be true RMS type and shall be accurate to $\pm 1\%$ of nominal voltage. Frequency sensing shall be accurate to $\pm 0.1\text{Hz}$. Time delay settings shall be accurate to $\pm 0.5\%$ of the full scale value of the time delay. The panel shall be capable of operating over a temperature range of -20 to + 70 degrees C, and storage from -55 to + 85 degrees C.
- D. The controller shall be enclosed with a protective cover and be mounted separate from the transfer switch unit for safety and ease of maintenance. Sensing and control logic shall be provided on printed circuit boards.

The controller shall meet To exceed the requirements for Electromagnetic Compatibility (EMC) as follows:

1. IEC 60947 – 6 – Multiple Function Equipment Transfer Switching Equipment
2. IEC 61000-4 Testing and Measurement Techniques
 - a. IEC 61000 – 4 - 2 Electrostatic Discharge Immunity
 - b. IEC 61000 – 4 - 3 Radiated RF Field Immunity
 - c. IEC 61000 – 4 - 4 Electrical Fast Transient/Burst Immunity
 - d. IEC 61000 – 4 - 5 Surge Immunity
 - e. IEC 61000 – 4 – 6 Conducted RF Immunity
3. CISPR 11 – Conducted RF Emissions and Radiated RF Emissions

2.4 ENCLOSURE

- A. The 3ADTS shall be furnished in a NEMA type 3R enclosure unless otherwise shown on the Drawings.
- B. Provide strip heater with thermostat for Type 3R enclosure requirements.
- C. Controller shall be mounted on, visible, and operational through enclosure door.

2.5 CONTROLLER DISPLAY AND KEYPAD

- A. A graphical LCD display and keypad shall be an integral part of the controller for viewing all available data and setting desired operational parameters.
- B. Operational parameters shall also be available for viewing and limited control through communications port. The following parameters shall only be adjustable via DIP switches on the controller.
 - 1. Nominal line voltage and frequency
 - 2. Single or three phase sensing on normal
 - 3. Transfer operating mode configuration, (open transition, or delayed transition)
- C. All instructions and controller settings shall be easily accessible, readable and accomplished without the use of codes, calculations, or instruction manuals.

2.6 VOLTAGE AND FREQUENCY SENSING

- A. Voltage and frequency on both the normal and emergency sources (as noted below) shall be continuously monitored, with the following pickup, dropout, and trip settings capabilities (values shown as % of nominal unless otherwise specified).

Parameter	Sources	Dropout/Trip	Pickup/Reset
Undervoltage	N & E	70 to 98%	85 to 100%
Overvoltage	N & E	102 to 116%	2% below trip
Underfrequency	N & E	85 to 98%	86 to 100%
Overfrequency	N & E	101 to 111%	2% below trip

- B. Repetitive accuracy of all settings shall be within 1% at +25°C.
- C. Voltage and frequency settings shall be field adjustable in 1% increments either locally with the display and keypad or remotely via serial communications port access.
- D. Source status screens shall be provided for both normal & emergency to provide digital readout of voltage and frequency. Note: Single phase on emergency
- E. The backlit 128*64 graphical display shall have multiple language capability. Languages can be selected from the user interface.

2.7 TIME DELAYS

- A. A time delay shall be provided to override momentary normal source outages and delay all transfer and engine starting signals, adjustable 0 to 6 seconds. It shall be possible to bypass the time delay from the controller user interface.
- B. A time delay shall be provided on transfer to emergency, adjustable from 0 to 60 minutes 59 seconds for controlled timing of transfer of loads to emergency. It shall be possible to bypass the time delay from the controller user interface.
- C. A generator stabilization time delay shall be provided after transfer to emergency adjustable 0 or 4 seconds.
- D. A time delay shall be provided on retransfer to normal, adjustable 0 to 9 hours 59 minutes 59 seconds. Time delay shall be automatically bypassed if emergency source fails and normal source is acceptable.
- E. A cooldown time delay shall be provided on shutdown of engine generator, adjustable 0 to 60 minutes 59 seconds.
- F. All adjustable time delays shall be field adjustable without the use of special tools.
- G. A time delay activated output signal shall also be provided to drive an external relay(s) for selective load disconnect control. The controller shall have the ability to activate an adjustable 0 to 5 minutes 59 seconds time delay in any of the following modes:
 - 1. Prior to transfer only.
 - 2. Prior to and after transfer.
 - 3. Normal to emergency only.
 - 4. Emergency to normal only.
 - 5. Normal to emergency and emergency to normal.
 - 6. All transfer conditions or only when both sources are available.
- H. In the event that the alternate source is not accepted within the configured failure to accept time delay, the common alert shall become active.
- I. The controller shall also include the following built-in time delay for delayed transition transfer operation.
 - 1. A time delay for the load disconnect position for delayed transition operation adjustable 0 to 5 minutes 59 seconds in 1 second increments.

2.8 ACCESSORIES

- A. Accessory Package - An accessory bundle shall be provided that includes:
1. A fully programmable engine exerciser with seven independent routines to exercise the engine generator, with or without load on a daily weekly, bi – weekly, or monthly basis.
 2. Event log display that shows event number, time and date of events, event type, and reason (if applicable). A minimum of 300 events shall be stored.
 3. RS – 485 communications port enabled.
 4. Common alarm output contact.
- B. Controller Power Supply - A backup power UPS shall be provided to allow controller to run for 3 minutes minimum without AC power. (This feature shall be equal to ASCO accessory 1UP, and shall be capable of being added to existing switches without modification).
- C. Expansion Module - A relay expansion module (REX) is a standard feature when delayed transition transfer is specified. A REX module shall also be provided for open transition transfer that includes one form C contact for source availability of the normal (18G) and emergency (18B) sources. Additional output relay shall be provided to indicate a common alarm. The REX module shall have the capability of being daisy chained for multiple sets of contacts. (This feature shall be equal to ASCO accessory 18RX, and shall be capable of being added to existing switches without modification).
- D. Current Sensing Card - A load current metering card shall be provided that measures either single or three phase load current. It shall include current transformers (CT's) and shorting block. Parameters shall be able to be viewed via the user interface. (This feature shall be equal to ASCO accessory 23GA (single phase), 23GB (three phase), and shall be capable of being added to existing switches without modification).
- E. Communications Module – Shall provide remote interface module to support monitoring of vendor's transfer switch, controller and optional power meter. Module shall provide status, analog parameters, event logs, equipment settings & configurations over embedded webpage and open protocol. Features shall include:
1. Email notifications and SNMP traps of selectable events and alarms may be sent to a mobile device or PC.
 2. Modbus TCP/IP, SNMP, HTTP, SMTP open protocols shall be simultaneously supported.
 3. Web app interface requiring user credentials to monitor and control the transfer switch supporting modern smart phones, tablets and PC browsers. User will be

able to view the dynamic one-line, ATS controls status, alarms, metering, event logging as well as settings.

4. Secure access shall be provided by requiring credentials for a minimum of 3 user privilege levels to the web app, monitor (view only), control (view and control) and administrator (view, control and change settings). 128-Bit AES encryption standard shall be supported for all means of connectivity.
 5. Shall allow for the initiating of transfers, retransfers, bypassing of active timers and the activating/deactivating of engine start signal shall be available over the embedded webpage and to the transfer switch vendor's monitoring equipment.
 6. An event log displaying a minimum of three-hundred (300) events shall be viewable and printable from the embedded webpages and accessible from supported open protocols.
 7. Four (4) 100 Mbps Ethernet copper RJ-45 ports, two (2) serial ports, and LEDs for diagnostics.
 8. DIN rail mountable.
- F. Transfer Alarm - An audible alarm with silencing feature shall be provided to signal each time transfer to emergency occurs. (This feature shall be equal to ASCO accessory 62W).
- G. Load Shed Circuit (Contact) – A load shed shall be initiated by opening of customer supplied contact to match generator set capacity to the load. Relay de – energization opens emergency contactor (CE) disconnecting the load from the emergency source. If the normal source is acceptable, normal source contactor (CN) is closed to connecting the load to the normal source. When the load is reconnected to normal the control panel is reset in readiness for the next normal source failure. (This feature shall be equal to ASCO accessory 30AA).
- H. Load Shed Circuit (Voltage) – A load shed shall be initiated by the removal of the control voltage to a relay to match generator capacity to the load. Relay de – energization opens emergency contactor (CE) disconnecting the load from emergency source. If the normal source is acceptable, normal source contactor (CN) is closed connecting the load to the normal source. When the load is reconnected to normal the control panel is reset in readiness for the next normal source failure. (This feature shall be equal to ASCO accessory 30BA*).
- I. Enclosure Heater - A 125 watt enclosure heater with transformer and thermostat (adjustable from 30° to 140° F) shall be provided for outdoor installations where type 3R, 4, are specified.
- J. I. Surge Suppression – A TVSS with a surge current rating of 65kA shall be provided with individually matched fused metal oxide varistors (MOVs). It shall include LED

status indication of normal operation, under voltage, power loss, phase loss or component failure. Shall include form C dry contacts for external alarm or monitoring. The unit shall be enclosed in a Noryl housing rated NEMA 4, 12, and 4X. Shall comply with UL 1449 3rd edition.

PART 3 - EXECUTION

3.1 GENERAL

- A. In addition to the requirements specified herein, execution shall be in accordance with the requirements of Specification Division 26 and Drawings.

3.2 TEST AND CERTIFICATION

- A. The complete 3ADTS shall be factory tested to ensure proper operation of the individual components and correct overall sequence of operation and to ensure that the operating transfer time, voltage, frequency and time delay settings are in compliance with the specification requirements.
- B. Upon request, the manufacturer shall provide a notarized letter certifying compliance with all of the requirements of this specification including compliance with the above codes and standards, and withstand and closing ratings. The certification shall identify, by serial number(s), the equipment involved. No exceptions to the specifications, other than those stipulated at the time of the submittal, shall be included in the certification.
- C. The ADTS manufacturer shall be certified to ISO 9001: 2008 International Quality Standard and the manufacturer shall have third party certification verifying quality assurance in design/development, production, installation and servicing in accordance with ISO 9001: 2008.

3.3 SERVICE REPRESENTATION

- A. The ADTS manufacturer shall maintain a national service organization of company-employed personnel located throughout the contiguous United States. The service center's personnel must be factory trained and must be on call 24 hours a day, 365 days a year.
- B. The manufacturer shall maintain records of switch shipments, by serial number, for a minimum of 20 years.
- C. For ease of maintenance, the transfer switch nameplate shall include drawing numbers and serviceable part numbers.

END OF SECTION

SECTION 265000

LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide labor, material, equipment, related services, and supervision required, including, but not limited to installation, connections and testing of all lighting fixtures and accessories as required for the complete performance of the work, as shown on the Drawings, as specified herein.
- B. RELATED SECTIONS
 - 1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
 - 2. Division 26 Section "Common Work Results for Electrical".

1.2 REFERENCES

- A. The equipment in this specification is designed and manufactured according to latest revision of the following standards (unless otherwise noted).
 - 1. Illuminating Engineering Society of North America (IESNA)
 - 2. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC)
 - 3. Underwriters Laboratories (UL)

1.3 SUBMITTALS

- A. Submit sufficient information to determine compliance with the Contract Documents. Identify submittal data with the specific equipment tags and/or service descriptions to which they pertain. Submittal data shall be clearly marked to identify the specific model numbers, options, and features of equipment and work proposed.
- B. Deviations from the Contract Documents shall be indicated within the submittal. Each deviation shall reference the corresponding drawing or specification number, show the Contract Document requirement text and/or illustration, and shall be accompanied by a detailed written justification for the deviation.

- C. Manufacturer shall provide copies of following documents to owner for review and evaluation in accordance with general requirements of Division 1 and Division 26.
1. Product data on specified product documenting the following
 - a. Interior lighting fixtures:
 - 1) Catalog data sheets and pictures.
 - 2) Fixture finish and metal gauge.
 - 3) Lens material, pattern, and thickness.
 - 4) Mounting or suspension details.
 - b. Exterior lighting fixtures:
 - 1) Catalog data sheets and pictures.
 - 2) Fixture finish and metal gauge.
 - 3) Lens material, pattern, and thickness.
 - 4) Fastening details to wall or pole.
 - 5) Light poles, dimensions and finish
 - c. Lighting fixtures submitted as equal to those in the schedule without accompanying equivalent digital IES photometric data file will be rejected.
- D. Provide a guarantee against defective materials and workmanship in accordance with requirements of the Section 260500 of these Specifications.

PART 2 - PRODUCTS

2.1 LIGHTING FIXTURES

A. General

1. Lighting fixtures shall be furnished as described in the fixture schedule and as indicated on the Drawings. All lighting fixtures shall be LED unless noted otherwise. Lighting fixtures shall be furnished complete with lamps, ballast and/or LED drivers, and dimmers as required for proper operation.
2. Exterior light fixtures shall be UL listed for operation in wet locations.

B. Finishes

1. Light fixture shall be medium bronze unless noted otherwise on the Fixture Schedule.

2.2 LIGHTING CONTACTOR

- A. Remote control lighting contactors shall be provided as indicated on the Drawings. Contactors shall have positive locking features and shall be non-combination mechanically held in both positions. Main contacts shall be double-break, continuous-duty rated 30 amperes, 600 volts ac, for all types of loads. Contactors shall be Eaton C30CN, GE CR460, Square D Class 8903 or equal.
- B. Contactor control panel shall be UL 508A listed and NEMA 12 rated for the environment unless noted otherwise. The short circuit current rating shall meet or exceed the available short circuit current indicated on the bus feeding the contactor.
- C. Enclosed lighting control shall be provided with control power transformer and HOA selector switch.
- D. Photoelectric controls shall be weatherproof, swivel adjustable, with built-in time delay to prevent accidental turnoff by momentary brightness. The photocell shall be rated 1800 VA, 120 volts ac, and shall be field adjustable from 1 ft/c turn-on to 15 ft/c turn-off.
- E. Provide photo cells as called for in the fixture schedule or shown on the drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install fixtures in accordance with the manufacturer's recommendation.
- B. Install fixtures plumb and level.
- C. Install each fixture with a junction box and any necessary supports for wire terminations.
- D. Contactor is responsible for the following:
 1. Provide and install mounting system, hangers, pendants, and ceiling bracing as required compatible with ceiling system shown on the Drawings.
 2. Coordinate fixtures, mounting hardware, trim and accessories with ceiling system as required, including work of other trades required to be mounted on ceiling or in ceiling space.

3. The proper support and mounting of lighting fixtures in accordance with NEC Article 410 Part IV. If required, lighting fixtures shall be provided with disconnects in accordance with NEC requirements. The fixture installation shall comply with applicable local code requirements of the authority having jurisdiction and the NEC.

3.2 ADJUSTING AND CLEANING

- A. Install all fuses.
- B. Clean interior lighting fixtures of dirt and construction debris upon completion of installation.
- C. Remove labels and markings from fixtures.
- D. Clean fingerprints and smudges from lenses and lamps.
- E. All lighting fixtures shall be clean at time of final acceptance.
- F. Adjust aimable fixtures to provide required light intensities.

END OF SECTION

SECTION 311000

SITE CLEARING

PART 1 - GENERAL

1.1 SUMMARY

- A. Protection of existing trees, vegetation, landscaping, and site improvements not scheduled for clearing which might be damaged by construction activities.
- B. Trimming of existing trees and vegetation as recommended by arborist for protection during construction activities.
- C. Clearing and grubbing of stumps and vegetation, and removal and disposal of debris, rubbish, designated trees, and site improvements.
- D. Topsoil stripping and stockpiling on-site.
- E. Topsoil stripping and removal from site.
- F. Temporary erosion control, siltation control, and dust control.
- G. Temporary protection of adjacent property, structures, benchmarks, and monuments.
- H. Temporary relocation of fencing and site improvements scheduled for reuse.
- I. Watering of trees and vegetation during construction activities.
- J. Removal and legal disposal of cleared materials.

1.2 SUBMITTALS

NOT USED

1.3 QUALITY ASSURANCE

- A. Comply with governing codes and regulations. Use experienced workers.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Tree protection, erosion control, siltation control, and dust control materials suitable for site conditions.

PART 3 - EXECUTION

3.1 CLEARING

- A. Prevent damage to existing improvements indicated to remain, including improvements on and off site. Protect existing trees and vegetation indicated to remain. Do not stockpile materials. Do not permit traffic within drip line of existing trees to remain. Provide and maintain temporary guards to encircle trees or groups of trees to remain whether or not irrigation system is removed or inoperable.
- B. Water vegetation as required to maintain health. Cover temporarily exposed roots with wet burlap and backfill as soon as possible. Coat cut plant surfaces with approved emulsified asphalt plant coating.
- C. Repair or replace vegetation which, has been damaged. Remove heavy growths of grass before stripping.
- D. Strip topsoil to depths encountered. Remove heavy growths before stripping.
- E. Completely remove all improvements including stumps and debris except for those indicated to remain. Remove below grade improvements at least 12 inches below finish grade and to the extent necessary so as not to interfere with new construction. Remove abandoned mechanical and electrical work as required.
- F. Prevent erosion and siltation of streets, catch basins and piping. Control windblown dust. Remove waste materials and unsuitable soil from site and dispose of in a legal manner.
- G. Minimize production of dust due to clearing operations; do not use water if that will result in ice, flooding, sedimentation of public waterways or storm sewers, or other pollution.

3.2 EXISTING UTILITIES AND BUILT ELEMENTS

- A. Coordinate work with utility companies; notify before starting work and comply with their requirements; obtain required permits.
- B. Protect existing utilities to remain in service whether onsite or offsite.
- C. Do not disrupt public utilities without permit from authority having jurisdiction.
- D. Protect existing structures and other elements that are not to be removed.

3.3 VEGETATION

- A. Remove trees, shrubs, brush, and stumps in areas to be covered by building structure, paving, lawns, and planting beds.
- B. Do not begin clearing until vegetation to be relocated has been removed.
- C. Do not remove or damage vegetation beyond indicated limits on construction plans
- D. Vegetation Removed: Do not burn, bury, landfill, or leave on site, except as indicated.

1. Chip, grind, crush, or shred vegetation for mulching, composting, or other purposes; preference should be given to on-site uses.
 2. Existing Stumps: Treat as specified for other vegetation removed; remove stumps and roots to depth of 18 inches (450 mm).
 3. Fill holes left by removal of stumps and roots, using suitable fill material, with top surface neat in appearance and smooth enough not to constitute a hazard to pedestrians.
- F. Restoration: If vegetation outside removal limits or within specified protective fences is damaged or destroyed due to subsequent construction operations, replace at no cost to Owner.

End of Section

SECTION 312513

EROSION AND SEDIMENTATION CONTROL

PART 1 – GENERAL

1.1 SUMMARY

- A. Provide stone riprap for slope protection over prepared subgrade.
- B. Provide mud/silt retaining systems.
- C. Provide erosion control matting.
- D. Stormwater monitoring.

1.2 SUBMITTALS

- A. Product Data: Submit manufacturer's product data and installation instructions for each material and product used, including:
 - 1. Types of stone and sizes.
 - 2. Types of fabrics and erosion control matting.

1.3 QUALITY ASSURANCE

- A. Comply with governing codes and regulations. Provide products of acceptable manufacturers which have been in satisfactory use in similar service for three years. Use experienced installers. Deliver, handle, and store materials in accordance with manufacturer's instructions.

1.4 PERFORMANCE REQUIREMENTS

- A. Comply with all requirements of U.S. Environmental Protection Agency and South Carolina Department of Health and Environmental Control for erosion and sedimentation control, as specified for the National Pollutant Discharge Elimination System (NPDES), Phases I and II, under requirements for the 2012 Construction General Permit (CGP), and any updates required but not listed, whether the project is required by law to comply or not.
- B. Also comply with all more stringent requirements of City of Pikeville.
- C. Follow the Stormwater Pollution Prevention Plan and submit periodic inspection reports.
- D. Do not begin clearing, grading, or other work involving disturbance of ground surface cover until applicable permits have been obtained.
- E. Erosion On Site: Minimize wind, water, and vehicular erosion of soil on project site due to construction activities for this project.

1. If erosion occurs due to non-compliance with these requirements, restore eroded areas at no cost to UPS.
- F. Sedimentation of Waterways On Site: Prevent sedimentation of waterways on the project site, including rivers, streams, lakes, ponds, open drainage ways, storm sewers, and sanitary sewers.
1. If sedimentation occurs, install or correct preventive measures immediately at no cost to UPS; remove deposited sediments; comply with requirements of authorities having jurisdiction.
 2. If sediment basins are used as temporary preventive measures, pump dry and remove deposited sediment after each storm.
- G. Discharge monitoring: Monitor discharges as required and where required.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Crushed stone bedding 2' thick, with filter fabric, and mechanically placed 1' thick stone riprap.
- B. Retaining wall systems: Modular retaining wall system by Keystone or Risi Stone or approved equal.
- C. Erosion control matting: By Akzo or Greenstreak of the following type.
1. Nonwoven polyester geotextile
 2. Polyvinyl chloride non-woven mat.
 3. Nylon geomatrix.
 4. Approved equal.
- D. Temporary erosion control materials
1. Silt Fence Fabric: Polypropylene geotextile resistant to common soil chemicals, mildew, and insects; non-biodegradable; in longest lengths possible; fabric including seams with the following minimum average roll lengths:
 - a. Average Opening Size: 30 U.S. Std. Sieve (0.600 mm), maximum, when tested in accordance with ASTM D 4751.
 - b. Permittivity: 0.05 sec^{-1} , minimum, when tested in accordance with ASTM D 4491.
 - c. Ultraviolet Resistance: Retaining at least 70 percent of tensile strength, when tested in accordance with ASTM D 4355 after 500 hours exposure.
 - d. Tensile Strength: 100 lb-f (450 N), minimum, in cross-machine direction; 124 lb-f (550 N), minimum, in machine direction, when tested in accordance with ASTM D 4632.
 - e. Elongation: 15 to 30 percent, when tested in accordance with ASTM D 4632.

- f. Tear Strength: 55 lb-f (245 N), minimum, when tested in accordance with ASTM D 4533.
- g. Color: Manufacturer's standard, with embedment and fastener lines preprinted.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install materials and systems in accordance with manufacturer's instructions and approved submittals. Install materials and systems in proper relation with adjacent construction. Coordinate with work of other sections.

End of Section

SECTION 313000
EARTHWORK

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide excavation, trenching, filter fabric, back-filling, filling, compaction and grading.

1.2 SUBMITTALS

None

1.3 QUALITY ASSURANCE

None

1.5 REFERENCE STANDARDS

- A. AASHTO T 180 - Standard Specification for Moisture-Density Relations of Soils Using a 4.54 kg (10-lb) Rammer and a 457 mm (18 in.) Drop; American Association of State Highway and Transportation Officials; 2001 (2004).
- B. ASTM D 2922 - Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth); 2005.
- C. ASTM D 4318 - Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils; 2005.

1.6 UNIT PRICE FOR UNSUITABLE SOIL MATERIALS

A. Unsuitable Soil Materials:

1. UPS Project Engineer exclusively shall make the determination of unsuitable soil materials.
2. Excavation, replacement and disposal of unsuitable soil materials, if any, shall be considered additional work to that indicated on the Drawings, specified, or reasonably inferred by the Contract Documents and, by appropriate change order, be charged to the Owner and the cost to Owner shall be determined in the manner provided in the General Conditions.
3. Measurement of the quantity of unsuitable soil materials shall be accurately made by Contractor and verified by the UPS Project Engineer.
4. The quantity of unsuitable soil materials excavated, replaced and disposed of shall, for payment purposes, be the actual volume of the excavation, calculated from grades determined before and after the work at the excavation area.
5. Excavation required by the Contract Documents and excavation, replacement or

disposal of soil materials required because of Contractor's failure to comply with the Contract Documents shall not be compensated as unsuitable soil materials.

1.7 PROJECT CONDITIONS

- A. Locate existing underground utilities in areas of work. If utilities are to remain in place, provide adequate means of protection during earthwork operations. Do not use explosives.

1.8 MAINTENANCE/OPERATION

- A. Do not allow water to accumulate in excavations or graded areas.
- B. Protect graded areas from traffic and erosion. Repair and reestablish grades in settled, eroded, and rutted areas.
- C. Where completed compacted areas are disturbed by subsequent construction operations or adverse weather, remove and replace or scarify soil materials, reshape, and re-compact to specified density prior to further construction.

PART 2 – PRODUCTS

2.1 BACKFILL AND FILL MATERIALS

- A. Unless other materials are specifically indicated for backfilling and filling, use soil materials excavated from site or Common Fill Materials specified herein.
- B. Untreated aggregate base material (Meet as TM 2940)

Requirements	Test Results
CBR min	80
Liquid Limits (max)	25
Passing #200 Sieve	7
(min) Sand Equivalent	35
(min) Opt Moisture by wt.	1.5% +/-
Minimum density	100%

- C. Common Fill Materials: On site or off site sand (SP, SW, or SC) with a maximum liquid limit of 25, free of organics or other deleterious materials.
- D. Select Fill Under Interior Floor Slabs-On-Grade: Washed, evenly graded mixture of crushed stone, or crushed or uncrushed gravel, with 100 percent passing a 1-1/2 inch sieve and not more than 5 percent passing a No. 4 sieve.
- E. Sand Backfill: Natural river or bank sand; free of silt, clay, loam, friable or soluble materials, and organic matter.
- F. Stone Crushings for Fiberglass Underground Fuel Tanks and Piping: Free flowing crushed stone; 1/8 inch minimum size to 1/2 inch maximum size; washed, free of clay, shale and organic matter; complying with ASTM C33, paragraph 9.1 requirements, except particles passing a #8 sieve are not permitted.

- G. Crushed Stone for Under Manholes: Washed natural stone; crushed or uncrushed; 3/4 inch minimum to 1 inch maximum size; free of clay, shale, sand, debris and organic matter.
- H. Rip Rap: Washed natural stone; crushed or uncrushed; with 100 percent passing a 12 inch sieve, 30 to 50 percent passing a 6 inch sieve, and 0 percent passing a 3 inch sieve; free of clay, shale, sand, debris and organic matter.
 - 1. Render all backfill and fill materials free of rock or gravel larger than 2 inches in any dimension, debris, waste, frozen parts, vegetation and other deleterious matter.
- I. Granular Fill – in accordance with AASHTO M147, with a liquid limit of not more than 25 and a plasticity index of not more than 5 in accordance with ASTM D318.
- J. Topsoil - Fill Type: Topsoil excavated on-site.
 - 1. Free of roots, rocks larger than 1/2 inch (12 mm), subsoil, debris, large weeds and foreign matter.
 - 2. Conforming to ASTM D2487 Group Symbol OH.

2.2 FILTER FABRIC

- A. Filter fabric shall be of nonwoven needle punched construction composed of polypropylene, polyethylene or polyamide fibers. The fabric should be free of any chemical treatment or coating, allow the passage of water and be inert to chemicals commonly found in soil.
- B. Acceptable Manufacturers and Products:
 - 1. Reemay, Inc., 70 Old Hickory Blvd., Old Hickory, TN. 37215, TYPAR 3401
 - 2. Hoechst Celanese Corp./Spunbond Business Unit, P.O. Box 5887, Spartanburg, SC. 29307, TREVIRA "S"1120]
 - 3. Phillips Fibers Corp., SUPAC 4NP
 - 4. Contractor may submit filter fabric equivalent to those listed above to Engineer for approval a minimum of two weeks prior to its use on the project.

PART 3 - EXECUTION

3.1 EXCAVATION

- A. Excavate site materials to establish required elevations. Excavate loose soils to an approximate depth of four feet below existing grades and extending five feet beyond exterior limits of building and pavement areas. Vertical extent of excavation of loose soils shall be verified in the field by geotechnical personnel utilizing hand augers and dynamic cone penetrometers. Test holes shall extend to a minimum depth of five (5) feet below existing grades. Test holes shall be obtained a minimum of two per structure or pavement area. For pavement areas larger than 5000 square feet, a minimum of one test shall be taken per 2500 feet of pavement area or fraction thereof. Excavation may be terminated at less than four feet below existing grade provided the

cone penetrometer test encounters soils with equivalent N values of 8 or greater.

- B. Excavate trenches for piping and conduit to the uniform width required for 6 to 9 inches clearance on both sides of pipe or conduit, except where additional width is required for proper installation of joints, fittings, valves and other work, and except where otherwise indicated.
- C. Carry depth of trenches for piping to establish indicated flow lines and invert elevations.
- D. Excavate for exterior water-bearing piping so that top of piping will not be less than 18 inches vertical distance below finished grade, unless otherwise indicated.
- E. Excavate for electrical conduit so that top of conduit will not be less than 18 inches vertical distance below finished grade.
- F. Trim bottoms of excavations to leave solid base to receive other work. Keep excavation bottoms clean and clear of loose materials.
- G. Protect excavation bottoms against freezing when atmospheric temperature is less than 35 degrees F.
- H. Correct unauthorized excavation in a manner acceptable to UPS Project Engineer, at no cost to Owner.

3.2 FILTER FABRIC INSTALLATION

- A. Line excavations with filter fabric where indicated on drawings.
- B. Overlap adjoining fabric panels at least 18".

3.3 BACKFILLING AND FILLING

- A. Place specified backfill and fill materials in layers to establish required elevations.
- B. Do not place backfill or fill materials on surfaces that are muddy, frozen, or contain frost or ice.
- C. Remove rock or gravel larger than 2 inches in any dimension, debris, waste, obstructions, and deleterious matter from ground surface prior to placement of fills.
- D. Plow, strip, or break-up sloped surfaces steeper than 1 vertical to 4 horizontal so that fill materials will bond with existing surface.
- E. When subgrade has a density less than that specified herein under "Compaction", break up ground surface, pulverize, moisture-condition to optimum moisture content, and compact to specified depth and percentage of maximum density or relative density.
- F. Place backfill and fill materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.
- G. Place backfill and fill materials uniformly around structures, materials and equipment to approximately same elevation in each lift.
- H. Completely fill and compact under piping and conduit. Shape fill to fit bottom

90 degrees of cylinder. Support piping and conduit during placement and compaction of bedding fill.

- I. Moisten or aerate each layer of backfill or fill prior to compaction as necessary to provide optimum moisture content. Compact each layer to specified percentage of maximum density or relative density.
- J. Granular Fill: Place and compact materials in equal continuous layers not exceeding 6 inches (150 mm) compacted depth.
- K. Soil Fill: Place and compact material in equal continuous layers not exceeding 8 inches (200 mm) compacted depth.
- L. Minimum Compaction Density Unless Otherwise Specified or Indicated:
 - a. Under paving, slabs-on-grade, and similar construction: 95 percent of maximum dry density with final lift 98 percent of maximum dry density.
 - b. At other locations: 95 percent of maximum dry density.

3.4 COMPACTION

- A. Compact soil to not less than the following percentages of maximum density for soils which exhibit a well-defined moisture density relationship (cohesive soils) determined in accordance with ASTM D1557 method.
- B. Compaction of Subgrade and
 - 1. Under Buildings (including future) and Paving Areas: Compact top 8 inches of exposed ground surface after excavation and each layer of backfill or fill material to 95 percent maximum density. Final lift shall be compacted to 98 percent of maximum density.
 - 2. Other Areas: Compact top 8 inches of existing ground surface and each layer of backfill or fill material to 95 percent maximum density.
- C. Where soil materials must be moisture conditioned before compaction, uniformly apply water to surface. Prevent free water from appearing on surface of soil materials during or subsequent to compaction operations.
- D. Remove and replace, or scarify and air dry, soil material that is too wet to permit compaction to specified density.
- E. Compact soil materials around piping and conduit with hand-operated tampers.
- F. Do not allow heavy vehicles, equipment or machinery to operate directly over piping and conduit until a minimum of 18 inches of backfill has been placed and compacted.

3.5 PROOF ROLLING

- A. Proof roll site after the top 12 inches of the sub-grade have been shaped and compacted to specifications. Sub-grade should be at or near optimum moisture content.
- B. For soil type(s) A-3, A-4, A-6, and A-7, use 35 ton roller with a tire pressure of 120 psi. For granular soils or soil, rock, and granular mixtures, use 50 ton roller with 150 psi tire pressure.
- C. The sub-grade area where the proof rolling has taken place is considered "Failed" based on the following:

1. New Construction
 - a. Permanent rutting in excess of 1 inch.
 - b. Elastic (rebound) movement or rutting is in excess of 1 inch with substantial cracking or sustainable lateral movement.
 2. Reconstruction
 - a. Permanent rutting in excess of ½ inch.
 - b. Elastic (rebound) movement is in excess of ½ inch with substantial cracking or sustainable lateral movement.
- D. Soil excavated as a result of proof rolling shall be considered “Unsuitable” as determined by the Project Engineer and is to be excavated, replaced and disposed off site, if Project Engineer so directs.

3.6 GRADING

- A. Grade site to establish required elevations.

3.7 UNSUITABLE SOIL MATERIALS

- A. Excavate, replace and dispose of site soil materials determined to be unsuitable by UPS Project Engineer, if UPS Project Engineer so directs.
- B. Replace unsuitable soil materials with Common Fill Materials specified. Backfill, compact and grade the replacement materials as specified herein.
- C. Dispose of unsuitable soil materials as directed by the UPS Project Engineer.

3.8 TOLERANCES

- A. Perform earthwork operations to establish required elevations and dimensions within the following tolerances, except that no tolerance will be permitted that would allow a lesser size than indicated for footings and foundations or a lesser thickness than indicated for paving, paving base courses and concrete floor slabs-on-grade.
 1. Under Buildings and Paving Areas: Plus or minus 1/2 inch.
 2. Other Areas: Plus or minus 1 inch.

3.9 FIELD QUALITY CONTROL

- A. The Owner will furnish testing and inspection services during earthwork operations. Such services will include general inspections of earthwork operations, testing of fill materials and compaction, and inspection of excavations to such extent as determined by UPS Project Engineer.

3.10 REMOVAL

- A. Remove excess excavated material, rock and gravel, debris, waste, vegetation and deleterious matter from earthwork operations and dispose of off site.

End of Section

SECTION 313116 - TERMITE CONTROL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Soil treatment with termiticide.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of termite control product.
 - 1. Include the EPA-Registered Label for termiticide products.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Product Certificates: For termite control products, from manufacturer.
- C. Soil Treatment Application Report: After application of termiticide is completed, submit report for Owner's records and include the following:
 - 1. Date and time of application.
 - 2. Moisture content of soil before application.
 - 3. Termiticide brand name and manufacturer.
 - 4. Quantity of undiluted termiticide used.
 - 5. Dilutions, methods, volumes used, and rates of application.
 - 6. Areas of application.
 - 7. Water source for application.
- D. Warranties: Sample of special warranties.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: A specialist who is licensed according to regulations of authorities having jurisdiction to apply termite control treatment and products in jurisdiction where Project is located, and who employs workers trained and approved by manufacturer to install manufacturer's products.
- B. Regulatory Requirements: Formulate and apply termiticides and termiticide devices according to the EPA-Registered Label.

1.6 PROJECT CONDITIONS

- A. Environmental Limitations: To ensure penetration, do not treat soil that is water saturated or frozen. Do not treat soil while precipitation is occurring. Comply with requirements of the EPA-Registered Label and requirements of authorities having jurisdiction.
- B. Coordinate soil treatment application with excavating, filling, grading, and concreting operations. Treat soil under footings, grade beams, and ground-supported slabs before construction.

1.7 WARRANTY

- A. Soil Treatment Special Warranty: Manufacturer's standard form, signed by Applicator and Contractor, certifying that termite control work, consisting of applied soil termiticide treatment, will prevent infestation of subterranean termites. If subterranean termite activity or damage is discovered during warranty period, re-treat soil and repair or replace damage caused by termite infestation.
 - 1. Warranty Period: Three years from date of Substantial Completion.

1.8 MAINTENANCE SERVICE

- A. Continuing Service: Beginning at Substantial Completion, provide 12 months' continuing service including monitoring, inspection, and re-treatment for occurrences of termite activity. Provide a standard continuing service agreement. State services, obligations, conditions, terms for agreement period, and terms for future renewal options.

PART 2 - PRODUCTS

2.1 SOIL TREATMENT

- A. Termiticide: Provide an EPA-Registered termiticide, complying with requirements of authorities having jurisdiction, in an aqueous solution formulated to prevent termite infestation.

Provide quantity required for application at the label volume and rate for the maximum termiticide concentration allowed for each specific use, according to product's EPA-Registered Label.

1. Products: Subject to compliance with requirements, [provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:
 - a. BASF Corporation, Agricultural Products; Termidor.
 - b. Bayer Environmental Science; Premise 75.
 - c. FMC Corporation, Agricultural Products Group.
 - d. Syngenta.
 - e. Approved equal.
2. Service Life of Treatment: Soil treatment termiticide that is effective for not less than three years against infestation of subterranean termites.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Applicator present, for compliance with requirements for moisture content of soil per termiticide label requirements, interfaces with earthwork, slab and foundation work, landscaping, utility installation, and other conditions affecting performance of termite control.
- B. Proceed with application only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. General: Comply with the most stringent requirements of authorities having jurisdiction and with manufacturer's written instructions for preparation before beginning application of termite control treatment. Remove all extraneous sources of wood cellulose and other edible materials such as wood debris, tree stumps and roots, stakes, formwork, and construction waste wood from soil within and around foundations.
- B. Soil Treatment Preparation: Remove foreign matter and impermeable soil materials that could decrease treatment effectiveness on areas to be treated. Loosen, rake, and level soil to be treated except previously compacted areas under slabs and footings. Termiticides may be applied before placing compacted fill under slabs if recommended in writing by termiticide manufacturer.
 1. Fit filling hose connected to water source at the site with a backflow preventer, complying with requirements of authorities having jurisdiction.

3.3 APPLICATION, GENERAL

- A. General: Comply with the most stringent requirements of authorities having jurisdiction and with manufacturer's EPA-Registered Label for products.

3.4 APPLYING SOIL TREATMENT

- A. Application: Mix soil treatment termiticide solution to a uniform consistency. Provide quantity required for application at the label volume and rate for the maximum specified concentration of termiticide, according to manufacturer's EPA-Registered Label, to the following so that a continuous horizontal and vertical termiticidal barrier or treated zone is established around and under building construction. Distribute treatment evenly.
 - 1. Slabs-on-Grade and Basement Slabs: Under ground-supported slab construction, including footings, building slabs, and attached slabs as an overall treatment. Treat soil materials before concrete footings and slabs are placed.
 - 2. Foundations: Adjacent soil, including soil along the entire inside perimeter of foundation walls; along both sides of interior partition walls; around plumbing pipes and electric conduit penetrating the slab; around interior column footers, piers, and chimney bases; and along the entire outside perimeter, from grade to bottom of footing. Avoid soil washout around footings.
 - 3. Crawlspace: Soil under and adjacent to foundations as previously indicated. Treat adjacent areas including around entrance platform, porches, and equipment bases. Apply overall treatment only where attached concrete platform and porches are on fill or ground.
 - 4. Masonry: Treat voids.
 - 5. Penetrations: At expansion joints, control joints, and areas where slabs will be penetrated.
- B. Avoid disturbance of treated soil after application. Keep off treated areas until completely dry.
- C. Protect termiticide solution, dispersed in treated soils and fills, from being diluted until ground-supported slabs are installed. Use waterproof barrier according to EPA-Registered Label instructions.
- D. Post warning signs in areas of application.
- E. Reapply soil treatment solution to areas disturbed by subsequent excavation, grading, landscaping, or other construction activities following application.

END OF SECTION 313116

SECTION 321126.19

BITUMINOUS STABILIZED BASE COURSES

1. SCOPE:

Under this heading shall be included the furnishing and installation of base course and pavement as shown including subgrade preparation, base course and pavement.

2. GENERAL:

Subgrade preparation shall include leveling, proof-rolling and compacting of the subgrade as required. Installation of the base course shall include the placing and compacting of the material with appropriate equipment. Pavement shall be placed as shown on the plans with the necessary equipment and shall include any prime coats or tack coats required. All work shall be in conformity with the lines, grades and typical cross-sections shown on the Plans. The Contractor must have all equipment and workers on the job site necessary to perform a given operation when it is initiated.

3. SUBGRADE PREPARATION:

The subgrade shall be brought to the line and grade necessary to accommodate the base and pavement at the required finished grades. All subgrade shall be proof-rolled as specified, before base course is placed on the subgrade.

4. BASE COURSE:

a) Preparation of Base.

The surface of the base course will be inspected by the Engineer for adequate compaction and surface tolerances specified in applicable base course or sub-base course. Any ruts or soft yielding spots that may appear in the base course, any areas having inadequate compaction, and any deviations of the surface from the requirements specified for the base course shall be corrected by loosening the affected areas, by removing unsatisfactory material and adding approved material where required, and by reshaping and recompacting to line and grade and to the specified density requirements. Compaction of base material shall be done by conventional means using a 30,000 to 40,000 pound vibratory roller or other means of obtaining the required compaction.

The lines and grades shown on the Contract Drawings for each pavement category of the Contract shall be established and maintained by means of line and grade stakes placed at the site of the work by the Contractor.

b) Graded Aggregate Base Course (***) Stabilized Aggregate Base Course).

The aggregate in the base course shall consist of a mixture of either crushed gravel, together with sand, sand-gravel, soil or other materials having similar characteristics combined as necessary to give a mixture conforming to the requirements, prescribed herein. The material and installation shall meet the requirements of the Tennessee Department of Transportation Standard Specifications)

(***)	<u>Sieve Designation</u>	<u>Percent By Weight Passing</u>	
	<u>Type 2</u>		
	1-1/2"	100	
	3/4"	65-100	
	1/2"	50-90	
	3/8"	45-70	
	No. 4	35-55	
	No. 3	17-38	
	No. 200	6-15	
	Liquid Limit	25 Max.	
	Plasticity Index	6 Max.)	
		<u>Group I</u>	<u>Group II</u>
	2"	100	100
	1-1/2"	97-100	97-100
	3/4"	60-95	60-90
	No. 10	25-50	25-45
	No. 60	10-35	5-30
	No. 200	7-15	4-11

e) Limerock Base Course.

At the Contractor's option limerock of either Miami or Ocala formation may be used, but limerock of only one formation may be used on any contract. Material shall meet the requirements of the Tennessee Department of Transportation Standard Specification.

The minimum percentage of carbonates of calcium and magnesium in the limerock material shall be 70. The maximum percentage of water sensitive clay material shall be 3.

The liquid limit shall not exceed 35 and the material shall be non-plastic.

Limerock material shall not contain cherty or other extremely hard pieces, or lumps, balls or pockets of sand or clay size material in sufficient quantity as to be detrimental to the proper bonding, finishing, or strength of the limerock base.

At least 97 percent (by weight) of the material shall pass a 1-1/2 sieve and the material shall be graded uniformly down to dust. The fine material shall consist entirely of dust of fracture. All crushing or breaking up which might be necessary in order to meet such size requirements shall be done before the material is placed on the road.

5. BITUMINOUS PRIME:

Bituminous prime shall be cutback asphalt RC-70, MC-70 or MC-30 applied at the rate of 0.25 gallons per square yards. The material and application shall comply with the applicable portions of the Department of Transportation Standard Specifications, and the material and application rate can be adjusted when the applicable section so recommends.

6. BITUMINOUS TACK COAT:

The bituminous tack coat shall be an asphaltic material which meets the requirements of the Tennessee Department of Transportation Standard Specifications. Application rate shall be at the rate indicated on the Plans.

7. BITUMINOUS PAVEMENT:

The bituminous wearing surface shall be a plant mix conforming to the requirements of Tennessee Department of Transportation Standard Specifications. The job mix shall meet the requirements of the Tennessee Standard Specifications.

A job mix formula indicating the single definite percentage for each sieve fraction of aggregate and for asphalt shall be submitted prior to surfacing operations. The job mix formula shall also show the percent voids, the percent voids filled with asphalt, and the unit weight per cubic foot of compacted mix.

The general composition limits are extreme ranges of tolerances to govern mixtures made from any raw materials meeting the specifications. The submission of the job mix formula shall bind the Contractor to furnish a paving mixture meeting the exact formula within allowable tolerances of plus or minus 1/2 percent for asphalt, plus or minus 7 percent of 1/2 inch and larger sieve sizes, plus or minus 5 percent for material passing the 1/2-inch sieve and retained on the No. 200, and plus or minus 1/2 percent of material passing the No. 200.

Compaction shall be done with an 8 to 10 ton steel-wheeled roller or other means approved by the Engineer. Thickness shall not vary more than one-fourth inch and smoothness shall not exceed one-eighth inch for a ten foot straight edge.

Base and pavement shall be cored for thickness at points determined by the Owner or his representative, at a minimum of 2 per 500 L.F. (one on edge and one on centerline with edge alternating). In areas of thickness deficiency, additional cores shall be taken as directed by the Owner, and deficiencies shall be remediated to the satisfaction of the Owner without recourse.

8. REMOVE AND REPLACE PAVEMENT:

Pavement and base course which must be removed for constructing sewers, manholes, force mains, water lines, and all other appurtenances in streets shall be replaced with the paving section shown on the drawings or match the existing pavement section. The pavement shall be removed to neat lines cut by a masonry saw. The top 18 inches of subgrade material immediately under the paving base and also road shoulder shall be carefully removed and kept separate from the rest of the excavated material. This material shall be placed in the top 18 inches of the backfill. Further compaction shall be accomplished by leaving the backfilled trench open to traffic while maintaining the surface with crushed stone or gravel. Settlement in trenches shall be refilled with crushed stone or gravel, and such maintenance shall continue until replacement of pavement.

9. TESTING:

The following tests will be made in accordance with the current edition of the appropriate Department of Transportation Standard Specifications.

At least one density determination shall be made for each 900 square yards of base. Asphalt extraction and aggregate gradation on the asphaltic concrete plant mix: one for each 200 tons of material, or fraction thereof, delivered to the job site.

10. PROOF ROLLING:

Proof-rolling will be done with a fully loaded tandem axle dump truck capable of transferring a load in excess of 20 tons. Test rolling will be done parallel to the centerline at speeds between 2 and 5 miles per hour. Areas where pumping, rutting or excessive deflection is observed after successive passes will be undercut, backfilled and properly compacted.

11. PAINTED LINES FOR PARKING AND TRAFFIC AREAS:

Painted lines shall be as shown on the Plans. Paint and all work shall be accordance with the Tennessee Standard Specifications. Glass beads are not required. The paint manufacturer shall submit a statement which certifies that the paint meets the Department of Transportation specifications. Owner will select the color of paint to be used.

12. SUBGRADE STERILIZATION:

The Engineer will inspect the subgrade before paving. In areas specified by the Engineer, the Contractor will sterilize the subgrade with ½ pound of Parmitol No. 5 PG (manufactured by CIBA-GEIGY) per 100 square feet.

13. MEASUREMENT AND PAYMENT:

Measurement and payment will be as provided for in Section 01150, Measurement and Payment.

END OF SECTION

SECTION 321313

CONCRETE PAVEMENT

15. SCOPE:

Under this heading shall be included the construction of concrete pavements.

2. STANDARD SPECIFICATIONS:

All work under this Section shall be performed in accordance with the Tennessee State Highway Department "Standard Specifications for Highway Construction" hereinafter referred to as the Standard Specifications, unless specifically changed by the Drawings or the requirements of this Section of the Project Specifications.

3. MATERIALS:

15) Aggregate.

Coarse aggregate shall be crushed stone and shall conform to the requirements of the Standard Specifications and shall meet the requirements of Class A, Group 1 with respect to wear resistance. Fine aggregate shall conform to the Standard Specifications.

b) Cement.

Cement shall conform to the requirements of ASTM C-150, Type I.

c) Water.

Water used in mixing and curing shall be of potable quality.

d) Joint Sealer.

Sealer for joints shall meet the requirements of the Standard Specifications.

e) Joint Filler.

Preformed joint filler shall meet the requirements of the Standard Specifications and shall be furnished in a single piece for the full width and depth of the required joint.

f) Dowels and Tie Bars.

Reinforcement for concrete pavements shall meet the requirements of the Standard Specifications.

g) Admixtures.

The Contractor shall submit certificates indicating that the material to be furnished meets all of the requirements indicated below. In addition, the Engineer may require the Contractor to submit complete test data from an approved laboratory showing that the material to be furnished meets all of the requirements of the cited specifications. Subsequent tests may be made of samples taken or proposed for use in the work to determine whether the admixture is uniform in quality with that approved.

15) Air-Entraining Admixtures.

Air-entraining admixtures shall meet the requirements of ASTM C260 and shall be added to the mixer in the amount necessary to produce the specified air content. The air-entrainment agent and the water reducer admixture, if used together, shall be compatible.

2) Water-Reducing Admixtures.

Water-reducing, set-controlling admixtures shall meet the requirements of ASTM C494, Type A, water-reducing or Type D, water-reducing and retarding. Water-reducing admixtures shall be added at the mixer separately from air-entraining admixtures in accordance with the manufacturer's printed instructions.

h) Forms.

Forms for use in pavement construction shall be of metal construction, free of dents, bends and warps, and shall be cleaned and oiled prior to each use. Forms shall extend to the full height of the required pavement section and shall be sealed at joints as required to prevent grout loss and to insure a continuous smooth surface on the finished pavement.

15) Curing Agents.

Materials for curing shall conform to the requirements of the Standard Specifications.

4. EQUIPMENT:

Equipment shall meet the requirements of the Standard Specifications and the additional requirements as specified herein.

5. CONSTRUCTION:

Concrete pavement construction shall be in accordance with the Standard Specifications except as modified herein.

6. PROPORTIONS:

Concrete mixes shall be designed to have the proportions of materials to provide a 28 day minimum flexural strength of 600 psi (***) 550 psi @ 14 days), an entrained air content of 4.0 to 5.5 percent, a maximum slump of 2.5 inches and a maximum water-cement ratio (lbs./lb.) of 0.53, as required for Class No. 1 (***) delete class for South Carolina) in accordance with section 430.3.06 of the Standard Specifications. The Contractor shall submit mix designs which have been verified by

laboratory testing and which meet the requirements for strength, air content, water-cement ratio and slump as given above in accordance with Section 430.3.06 (***) 501.11) of the Standard Specifications. Variations from approved mix designs, for whatever purpose, will be permitted only upon written request by the Contractor and accompanied by new mix designs and the results of verification tests. Water shall not be added to concrete at the site of the work for any reason.

7. JOINTS:

15) Joint Pattern.

The Contractor shall determine the joint pattern which best serves his equipment and operation. Joint spacing shall be within the limits shown on the Drawings except that the ratio of longitudinal to transverse spacing shall not exceed 1.25 and the maximum panel size will be 12-1/2 feet by 15 feet for concrete up to 8 inches thick. This ratio may be exceeded only at those intermediate joints at structure penetrations of the pavement. At such penetrations, an intermediate joint shall be constructed in the transverse direction which has an axis bisecting the penetration center. The Contractor shall submit for approval a jointing plan which includes, but is not limited to, the direction of paving and joint spacing dimensions, the type of joint as designated on the Drawings, the locations and intermediate joint locations at pavement penetrations and the sequence of paving operations. The plan shall be submitted to the Engineer at such time as required by the Standard Specifications for submittal of mix designs. Slight adjustment in location of drainage inlets will be permitted for the purpose of obtaining efficient joint patterns.

b) Sawed Joints.

The Contractor shall always maintain the necessary personnel and equipment on the site to ensure that joints are sawed at the appropriate time. Failure to saw joints at the appropriate stage of concrete set which results in uncontrolled cracking will be cause for the rejection of damaged pavement and such pavement shall be removed and replaced at no additional cost to the Owner.

c) Joint Filler.

Elastomeric joint filler shall only be placed on clean surfaces. All joint filler material yielded outside the joint and all over runs shall be removed.

8. FINISHING:

The surface shall have a broom (***) burlap) finish in accordance with the Standard Specifications.

9. CURING:

15) Requirements.

Curing shall be in accordance with the Standard Specifications except that for hot weather concreting, the use of burlap cover maintained in a wet condition for 7 days shall be required.

b) Control.

The Contractor shall always maintain the necessary personnel and equipment on the site to ensure that curing is initiated at the proper stage of concrete set. Uncontrolled cracking resulting from improper or untimely curing will be cause for rejection of the work and the removal and replacement of pavement at no additional cost to the Owner.

10. TESTING:

15) General.

All testing for quality assurance will be performed by a laboratory retained by Contractor (***) and approved by the Owner.

b) Strength.

Flexure testing shall be performed in accordance with AASHTO: T 126 and T 97. Each set for field control shall consist of 3 beam specimens obtained during concrete placement operations and 6 cylinders from the same load of material. Cylinders shall be tested in accordance with ASTM C496. Where adequate correlation is obtained, the Engineer may allow use of cylinders in place of beam testing.

c) Frequency.

The following table presents the minimum testing intervals for all concrete testing. The intervals may be increased during the work at the direction of the Engineer.

<u>TEST</u>	<u>FREQUENCY</u>
Flexure	One set per 800 square yards
Slump	One per each 3 delivery vehicles
Entrained Air	One per each 3 delivery vehicles
Density	One per each 5 delivery vehicles

12. CRACK CONTROL:

The Contractor shall have total responsibility for the prevention of uncontrolled cracking of pavements from any cause. Cracks in pavements shall be repaired by removal and replacement of concrete pavement at no cost to the Owner. Cracks that occur within 2 feet of a joint for their total length shall be repaired by removal and replacement of concrete pavement between the crack and the adjacent joint. Other cracks shall be repaired by total removal and replacement of all pavement within the panel formed by adjacent joints. Subgrade repair made necessary by corrective operations shall be performed at no cost to the Owner. In the event that uncontrolled cracking occurs in two or

more adjacent panels oriented in the direction of paving, the Contractor shall cease all placement of concrete and shall determine the cause. Upon determination of the cause, the Contractor shall submit to the Engineer such modifications to operations and/or materials as may be required to prevent additional cracking.

13. PAINTED STRIPES:

Parking and traffic stripes shall be installed in accordance with the Standard Specifications. Certification by the manufacturer that the paint to be used meets all requirements of the Specifications shall be submitted to the Engineer prior to any application.

14. USE:

The pavement shall be released to the Owner for use in completed condition at the end of the contract period. Such completion time shall include 28 days for curing. Use by the Owner will not constitute final acceptance for payment.

15. MEASUREMENT AND PAYMENT:

Measurement and payment will be as provided for in Section 01150, Measurement and Payment

END OF SECTION

SECTION 321613.13

CONCRETE SIDEWALKS, CURB AND GUTTER

1. SCOPE:

Under this heading shall be included the construction of all concrete sidewalks, curb, and gutter.

2. CONCRETE:

Concrete shall be composed of cement, admixtures, fine aggregate, coarse aggregate, and water proportioned and mixed to produce a plastic workable mix in accordance with the requirements of American Concrete Institute (ACI) Manual of Concrete Practice-1980 (MCP) and shall be suitable for the specific conditions of placement. Concrete shall be Class "A" per Tennessee DOT Standard Specification and shall have 28-day compressive strength of not less than 3,000 psi and contain not less than 611 pounds of cement per cubic yard of concrete. The maximum size of coarse, hard aggregate shall be 3/4-inch.

All concrete shall be ready mixed concrete in accordance with ASTM C94. All reinforcement shall comply with ASTM A615.

3. PREPARATION:

Before placing concrete, all debris and water shall be removed from the places to be occupied by the concrete. Wood forms shall be thoroughly wetted or oiled, and the reinforcement cleaned of coatings. Formwork and the placement of reinforcement, pipes, anchors, and other inserts shall be inspected by the Engineer before any concrete is deposited.

4. PLACING:

The placing and depositing of all concrete shall be done in accordance with requirements of the ACI. Concrete shall be rapidly handled from mixer to forms and deposited as nearly as possible in its final position to avoid segregation due to rehandling or flowing. Concrete shall not be allowed to drop freely more than 4 feet. For greater drop a tremie or other means must be used. Concrete shall be spaced and worked by hand and vibrated to assure close contact with all surfaces of forms and reinforcement and leveled off at proper grade to receive finish. No concrete that has partially hardened or been contaminated by foreign material shall be deposited in the work. Concrete shall never be deposited upon soft mud or dry porous earth.

5. VIBRATION:

Concrete shall be placed with the aid of manual vibration. The intensity of vibration shall be sufficient to cause flow or settlement of the concrete into place, but shall not be long enough to cause segregation of the mix. To secure even and dense surfaces, vibration shall be supplemented by hand spading in the corners and angles of forms and along form surfaces while

the concrete is plastic under the vibratory action. Caution must be exercised to prevent any injury to the inside face of the forms or any movement of the reinforcement.

6. CONSTRUCTION JOINTS, CONTROL JOINTS AND EXPANSION JOINTS:

Joints shall be formed and located as indicated on the Plans, or as recommended by applicable requirements of MCP. Final locations are subject to Engineer's review.

The rate and method of placing concrete and the arrangement of construction joint bulkheads shall be such that the concrete between construction joints shall be placed in a continuous operation. Whenever it is necessary to stop work, such stops shall be located, and temporary bulkheads erected. Before concreting is resumed, the surfaces of previously placed concrete shall be roughened, cleaned, wetted and slushed with grout immediately before additional concrete is placed. Grout shall be one part Portland Cement and two parts sand.

Expansion joints shall be provided in walks, and curb and gutter where shown and at walls, intersecting walks and buildings. Expansion joints in walks and curb and gutter shall be made with 1/2 inch thick premolded, non-extruding expansion joint filler, "Flexcell," or "Meadows" or approved equal, extending through the full thickness of the concrete except the upper 1/4 inch at 50 foot intervals. When sidewalk is adjacent to curb the expansion joints shall coincide. These shall be set accurately in place to straight lines and concreted in. Control joints in sidewalks shall be spaced at intervals equal to the width of the sidewalk and in curb and gutter at 10 foot intervals. Edges of grooves, expansion joints and edges of walks and curb and gutter shall be rounded to a 1/4 inch radius with suitable grooving and edging tools.

7. FINISHING:

Walks and curb and gutter shall be finished as specified for troweled concrete except that final finishing shall be with wood floats or broomed, as directed, to produce non-slippery finish at right angles to the length unless otherwise directed. Completed work shall be finished true to line and grade and when tested with a 10-foot straightedge shall not show a variation of more than 1/4 inch from a straight line.

8. PROTECTION AND CURING:

Protect concrete against frost, freezing temperatures, rapid drying and heavy rain after placing during this period, concrete shall be maintained above 70 degrees F. for at least 3 days or above 50 degrees F. for at least 5 days.

Walks and other exterior concrete shall be cured by covering first with sprayed-on curing compound applied immediately after finishing and then also completely covered with an impermeable fiber filled paper for a period of not less than 72 hours.

Membrane curing compound shall comply with ASTM C309 for Type I and paper shall comply with ASTM C171.

Exterior concrete work constructed during hot weather shall be protected, in addition to the curing specified above, with Spencer Kellogg Anti-Spalling Compound, or Carter-Waters "Dek-Seal," or approved equal, applied as soon as conditions will permit after curing and when the concrete is clean and dry. The mixture shall be applied uniformly in 2 applications, in accordance with the manufacturer's recommendations. The second application shall not be made until after the first coat has been completely absorbed by the concrete.

9. REMOVAL OF FORMS:

Care shall be taken in the removal of the forms not to damage the surface of the concrete. Immediately after the forms are removed, all damaged or imperfect work shall be patched in a neat and workmanlike manner, or if badly damaged or imperfect, the work shall be rebuilt. Leave shoring in place until concrete member will support its own weight safely plus any loads that may be placed upon it.

Freshly stripped surfaces shall not be pointed up or touched in any manner before having been inspected by the Engineer.

10. PATCHING AND FINISHING CONCRETE FORMED SURFACES:

Immediately after removing forms, all concrete surfaces shall be inspected, and any honeycomb, voids, stone pockets, and tie holes shall be patched before the concrete is thoroughly dry. Defective areas shall be chipped away to a depth of not less than 1 inch with the edges perpendicular to the surface. The area to be patched and a space of at least 6 inches wide surrounding it shall be wetted to prevent absorption of water from the patching mortar. The patch shall be finished in such a manner as to match the adjoining surface.

Immediately upon removing forms from finished concrete surfaces, they shall be cleaned of all cement fins and any air pockets shall be carefully filled with cement mortar worked in to ensure a bond with the concrete and finished off to match the surrounding surface.

All vertical exterior surfaces exposed in the finished work shall be finished to a smooth rubbed finish having a uniform appearance.

END OF SECTION

SECTION 323100

FENCES AND GATES

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide chain link fencing and gates for site perimeter and areas requiring separation.

1.2 SUBMITTALS

- A. Product Data: Submit manufacturer's product data and installation instructions for each material and product used.

1.3 QUALITY ASSURANCE

- A. Comply with governing codes and regulations. Provide products of acceptable manufacturers which have been in satisfactory use in similar service for three years. Use experienced installers. Deliver, handle, and store materials in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Steel Chain-Link Fence Fabric:

1. Mesh and Wire Size: 2 inch mesh, 0.148 inch diameter (9 gage).
2. Coating: ASTM A 817, Type 2, Class 2, zinc-coated (galvanized).
3. Coating: ASTM F 668, Class 1, PVC.

B. Framework:

1. Acceptable Types:
 - a. ASTM F1083, galvanized round steel pipe, standard weight (schedule 40), hot dip galvanized with not less than 1.8 oz./sq. ft.
 - b. Round steel pipe from ASTM A569 or ASTM A446 steel; 50,000 psi minimum yield strength; in compliance with AASHTO M181 requirements for interior and exterior coatings.
2. Line Posts: 2.375 inches diameter O.D..
3. End, Corner and Pull posts: 2.875 inches diameter O.D.
4. Gate Posts (for nominal width of gate leaf):
 - a. Up to 6 feet – 2.875 inches diameter O.D.
 - b. 6 to 13 feet – 4.000 inches diameter O.D.
 - c. 13 to 18 feet – 6.625 inches diameter O.D.
 - d. Over 18 feet – 8.625 inches diameter O.D.

5. Top Rail: 1.66 inches diameter O.D.; not less than 18 feet lengths; with expansion type couplings not less than 6 inches long; provided with means for securely attaching top rail to each end, corner, pull and gate post.
 6. Brace Rail: 1.66 diameter O.D. ; trussed to line posts with 3/8 inch diameter rod and adjustable tightener.
 7. Gate Frame: 1.90 inches diameter O.D. horizontal and vertical members provided to ensure proper gate operation and for attachment of fabric and hardware; members spaced not more than 8 feet apart, rigidly assembled by welding or with special fittings; and members extended and fitted with clips or other means for attaching 3 rows of barbed wire; provide with 3/8 inch diameter adjustable length truss rods.
- C. Post Tops: Combination with single, 45 degree barbed wire supporting arm; furnished with opening to permit passage of top rail; hot dip galvanized steel; fitted with clips or other means for attaching 3 rows of barbed wire; of sufficient strength to withstand a weight of 250 pounds applied at outermost end.
- D. Couplings, Bands, Clips, Wire Ties, Tension Bars, Fasteners and Fittings: Hot dip galvanized steel.
- E. Bottom Tension Wire: 7 gage, coil spring wire, galvanized or aluminized steel.
- F. Barbed Wire: 12-1/2 gage wire, 2 strands, with 14 gage 4-point barbs at not more than 5 inches o.c.; galvanized or aluminized steel.
- G. Gate Hardware: Hot dip galvanized steel, sized to ensure proper gate operation.
1. Hinges: Non-lift-off type, offset to permit 180 degree gate opening; 3 hinges per gate leaf.
 2. Latches: Plunger - bar type, except that forked type may be provided for personnel gates; with locking device and padlock eyes as integral part of latch.
 3. Keepers: Mechanical device which automatically engages gate leaf and holds it in open position until manually released; provided at vehicle gates.
 4. Stops: Gate stop pipe to engage center drop rod; provided at double gates.
- H. Concrete: As specified in Section 033000.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install materials in accordance with manufacturer's instructions and approved submittals. Comply with ASTM F 567. Install materials in proper relation with adjacent construction and with uniform appearance. Coordinate with work of other sections. Install posts to depth to avoid frost heave.
- B. Cut pipe with pipe-cutters only. Cutting with backsaws is not acceptable. Tack weld gates for strength. Use spring loaded latches, not yokes.
- C. Restore or replace damaged components. Clean and protect work from damage.

End of Section

SECTION 329000

PLANTING

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide landscape work:
 - 1. Trees, shrubs, plants, and ground cover.
 - 2. Finish grading and lawns.
 - 3. Topsoil and soil amendments.
 - 4. Initial maintenance of landscape materials.
 - 5. Pruning and relocation of existing plant materials.
 - 6. Reconditioning existing lawns.

1.2 SUBMITTALS

- A. Product Data: Submit manufacturer's product data and installation instructions for each material and product used.
- B. Notice: Submit 48-hour written notice prior to turnover to Owner for watering and maintenance.

1.3 QUALITY ASSURANCE

- A. Comply with governing codes and regulations. Provide products of acceptable manufacturers which have been in satisfactory use in similar service for three years. Use experienced installers. Deliver, handle, and store materials in accordance with manufacturer's instructions.
- B. Balled and Burlapped Plants and Trees: Graded to American Standard for Nursery Stock, ANSI Z60.1.
 - Testing: Laboratory testing by Contractor to determine for suitable soil amendments and fertilizer

1.4 DELIVERY, STORAGE, AND HANDLING:

- A. Delivery:
 - 1. Plant material shall be inspected upon arrival at the job site and unacceptable plant material shall be removed immediately from the job site.
 - 2. Plants shall be protected during delivery to prevent damage to the root balls or desiccation of leaves.
- B. Storage: Storage of materials shall be in areas designated or approved.
 - 1. Plant Storage: Plants not installed on the day of arrival at the site shall be stored and protected. Outside storage locations shall be continually shaded and protected from the wind. No plant material is to be stored on pavement. Bare root plants

shall be heeled-in Plants, including those in containers, shall be kept in a moist condition until planted by watering with a fine mist spray.

2. Storage of Other Materials: Soil conditions and amendments shall be kept in dry storage away from contaminants. Soil sterilant shall be isolated from any other landscape materials. Pesticide material shall be kept in dry storage, shall not contaminate adjacent material, and shall be handled and stored following manufacturer's directions.

C. Handling: Care shall be taken to avoid drying or damaging plants being moved from the nursery or storage area to the planting site. Balled and burlapped plants shall be handled carefully to avoid cracking or breaking the earth ball. Plants shall not be handled by the trunk or stems. Bare root plants shall be "puddled" when removed from the heeling-in bed to protect the roots from drying out. Plants shall be protected from freezing or drying by a covering of burlap, tarpaulin, or mulching material during transportation from the heeling-in bed to the planting site. Damaged plants will be rejected and shall be removed from the site.

1.5 WARRANTY

A. Warrant trees and shrubs for a period of two years against defects including death and unsatisfactory growth, except for defects resulting from neglect by Project Engineer abuse by others, or natural phenomena. Replace unsatisfactory plant material at end of warranty period at no additional expense to the Owner.

PART 2 - PRODUCTS

2.1 QUALITY:

- A. Plant material shall in all cases conform with ANSI 260.1 rules and grading adopted by the American Association of Nurserymen, Inc.
- B. Planting stock shall be well-branched and well-formed, sound, vigorous, healthy; free from disease, sunscald, windburn, abrasion, and shall have healthy, normal, unbroken, ungirdled root systems.
- C. All plants shall have been grown under the climatic conditions similar to those in the locality of the site of the project under construction or have been acclimated to such condition for at least two (2) years.
- D. Plants grown in containers shall be delivered and remain in containers in a shady location until planted. Plants in containers shall be watered prior to transportation and shall be kept moist until planted. The container must be removed prior to planting, care being exercised so as not to injure the plant.

2.2 MATERIALS

- A. Plant Materials:
 - 1. Deciduous trees.
 - 2. Deciduous shrubs.
 - 3. Coniferous and broadleaf evergreen trees and shrubs.

4. Ground cover.
 5. Plants.
- B. Lawns: Seed, new crop seed mixture; hydroseeding is acceptable.
- C. Lawns: Sod, strongly rooted, 2 years old.
- D. Lawns: Sod plugs and sprigs.
- E. Topsoil: Fertile, friable topsoil from offsite
1. If additional topsoil is required beyond that available from the stockpile, topsoil shall be a natural friable soil representative of productive soils in the vicinity. It shall be obtained from well-drained areas and be free of any admixture of subsoil, foreign matter, toxic substances, objects larger than 1" in diameter, and any material that may be harmful to plant growth.
 2. Topsoil shall meet the following characteristics
 - a. pH 5.3 to 6.5
 - b. Organic matter 5-10%
 - c. Sand 50-70%
 - d. Silt less than 30%
 - e. Clay 10-25%
- F. Topsoil: From site stockpile with additional fertile, friable topsoil from local source.
- G. Soil Amendments:
1. Lime: Dolomitic limestone.
 2. Aluminum Sulfate: Commercial grade.
 3. Peat Humus: Finely divided peat.
 4. Superphosphate: 20 percent available phosphoric acid.
 5. Sand: Clean, washed sand.
 6. Perlite: NBS PS 23.
 7. Sawdust: Rotted sawdust free of chips and stones.
 8. Manure: Rotted stable manure.
 9. Commercial Fertilizer: Neutral character for plant materials and lawns.
- H. Landscape Materials:
1. Gravel: Water-worn gravel.
 2. Anti-Erosion Mulch: Seed-free salt hay or threshed straw.
 3. Anti-Dessicant: Emulsion type, film-forming.
 4. Plastic Sheet: Black polyethylene, 8 mils.
 5. Filtration Fabric: Water permeable fiberglass or polypropylene fabric.
 6. Wrapping: Tree-wrap tape.
 7. Stakes and Guys: New hardwood, treated softwood, or redwood.
 8. Metal Edging: Commercial steel edging.

9. Wood Headers and Edging: All heart redwood or pressure treated southern yellow pine.
10. Mulch: Ground or shredded pine bark mulch, free of growth- or germination-inhibiting ingredients.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install materials in accordance with approved submittals. Install landscape work in proper relation with adjacent construction and with uniform appearance. Coordinate with work of other sections.
- B. Prepare topsoil by mixing fertilizer with loam. Apply fertilizer at a rate of 2 pounds of actual nitrogen per 1000 square feet for plant beds and 2 pounds per inch of trunk for tree pits.
- C. Install soil mix to a depth of 18" in plant beds.
- D. For seeded lawns, apply seed at rate of 5 pounds per 1000 square feet.
- E. For lawns with sod, place sod tightly, with grain in same direction.
- F. Excavate as required for trees and shrubs.
- G. Install plant material and backfill with soil mix. Stake and guy trees. Water thoroughly. Allow for soil settlement.
- H. Provide maintenance and watering until turnover to Owner's for maintenance and watering. Replace damaged materials and dead or unhealthy plants prior to turnover to Owner.

END OF SECTION

SECTION 329223

SODDING

1. SCOPE:

This section includes topsoiling, fertilizing, grassing, and sodding. In case of conflict between the requirements of this Section and the Landscaping Plan, the Landscaping Plan requirements shall govern.

2. GENERAL:

All disturbed areas resulting from work under this Contract shall be grassed. For roads under state jurisdiction, grassing on the right-of-way shall meet the requirements of the Department of Transportation Standard Specifications. The limits of sodding are shown on the Plans.

When the amount of grassing exceeds one acre, samples shall be taken and analyzed for pH, calcium, magnesium and Soil Fertility needs. The analyses shall be the basis for determining the composition and application rate of the fertilizer and lime, and possible varieties of grass. When these tests are taken the results shall be submitted to the Engineer.

3. TOPSOILING:

Topsoil shall be placed 4 inches to 6 inches deep over all areas to be grassed, using salvaged topsoil to the extent possible and topsoil from offsite borrow to supplement that salvaged. Topsoil shall be natural soil of the region, free from lumps, clay, toxic substance, sticks, debris, vegetation, stones over 1 inch in maximum dimension, and suitable for growing grass. Topsoil shall be spread over the areas to be grassed and shall be fine graded so as to be suitable for sowing.

4. FERTILIZING:

a) Material.

All areas to be grassed or sodded shall have fertilizer and lime applied as specified or as determined by the soil analyses.

Fertilizer shall be of such composition that when uniformly applied it will furnish not less than the following quantities of available plant food per 1,000 square feet:

Nitrogen	1.0 pounds
Phosphoric Acid	1.0 pounds
Potash	1.0 pounds

This is equivalent to a commercial 10-10-10 fertilizer. Commercial fertilizer blends which will give fractions exceeding these will be accepted, provided that no fraction exceeds the required by more than 2 times. The fertilizer shall be delivered to the job in original, unopened containers.

5. SEEDING:

Seed shall be delivered in suitable sealed containers labeled in accordance with applicable laws and regulations and including name and location of the producer. The pure live grass seed mixture shall be as follows:

a) Mixtures for Spring and Summer Planting-March 1 to September 1.

Bermuda, hulled (Cynodon dactylon)	10 lbs/acre	(March – June)
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Bermuda, unhulled (Cynodon dactylon)	10 lbs/acre	(July – August)
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b) Mixtures for Fall and Winter Planting-September 1 to March 1.

Annual Rye Grass (Lolium Temulentum)	40 lbs/acre
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OR

Bermuda (Unhulled) (Cynodon dactylon)	10 lb/acre
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Rye (Secale cereale)	30 lb/acre
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c) Application.

Seeds are to be sown by a mechanical spreader either hand operated or machine operated. Seeding equipment shall be such as will continuously mix the seeds to prevent segregation.

d) Soil Preparation.

Immediately before seeding, the soil shall have been properly prepared for seeding. Immediately after the seed has been sown, the entire area shall be raked lightly and rolled lightly to pack the soil firmly around the seed.

Seeded areas shall be moist when seeding and shall be kept moist by sprinkling until a good stand of grass is obtained (minimum of two weeks) and until the work is accepted by the Owner. Reseeding shall be done by the Contractor at his own expense as may be necessary to obtain a satisfactory stand of grass.

The Contractor shall use mulch or other additive materials when conditions do not

allow an acceptable stand of grass to grow. Mulch and additive materials shall contain no weed seeds.

6. SODDING:

a) Material.

Sod shall be good quality, densely-rooted Bermuda or centipede grass, free from noxious weeds. The sod shall be obtained from areas where soil is reasonably fertile and contains a high percentage of loamy topsoil. Before cutting, the sod shall be raked free of all debris and the grass cut to two inches. The thickness of the sod shall be such as to contain practically all of the dense root system of the grass not less than 1-1/2 inches. Sod shall be cut in uniform strips not less than 12 inches and not less than 24 inches in length and shall be placed within 48 hours of cutting.

b) Application.

Final sod will be placed once all site grading and wastewater structures are installed. Intermediate erosion control measures will be required while construction is occurring.

c) Soil Preparation.

Ground shall be prepared by excavating and turning to a depth of at least 4 inches. Fertilizer and lime shall be placed uniformly on the loosened soil then mixed in by means of a handrake or spike tooth harrow. The surface shall then be smoothed to accept the sod.

d) Placing Sod.

Sod shall be moist when laid and placed on a moist bed. The sod strips shall be carefully placed by hand, beginning at the toe of slopes and progressing upward, with the length of the strip at right angles to the direction of flow of surface water. All joints shall be tightly butted and end joints shall be staggered at least 12 inches. The sod shall be immediately pressed firmly into contact with bed by tamping or rolling. Screened soil shall be used to fill all joints between strips.

Sod on slopes shall be pegged with sod pegs to prevent displacement. Sod shall extend 18-inches over crest of slope. The sod shall be watered (minimum of 2 weeks), mowed, weeded, repaired or otherwise tended to insure the establishment of a uniform healthy stand of grass.

7. MAINTENANCE AND RESEEDING:

All seeded and sodded areas shall be maintained without additional payment until acceptance of the Contract and any regrading, refertilizing, reseeding or resodding shall be done at the Contractor's expense. Any areas which fail to show a "catch" or uniform stand, for any reason whatever, shall be reseeded or resodded with the original mixture, and such reseeding or resodding shall be repeated until final acceptance. The Contractor shall properly water, mow, and otherwise maintain all seeded and sodded areas until final acceptance.

Damage resulting from erosion, gulleys, washouts, or other causes shall be repaired by filling with topsoil, tamping, refertilizing, and reseeding or resodding by the Contractor at his expense if such damage occurs prior to acceptance of the Contract.

8. SUBMITTAL:

Manufacturer's data shall be submitted to the Engineer on grass seed, sod and fertilizer before the materials are delivered to the project site.

9. MEASUREMENT AND PAYMENT:

Measurement and payment for items provided under this Section shall be as described in Section 01150.

END OF SECTION

SECTION 331000

WATER DISTRIBUTION

PART 1 – GENERAL

1.1 SUMMARY

- A. Provide an operating underground, exterior water service piping system. Include piping, control valves, and steel and concrete anchorages. Include water service system and piping, accessories, and appurtenances for potable water and fire service outside the building.

1.2 SUBMITTALS

- A. Product Data: Submit manufacturer's product data and installation instructions for each material and product used.
- B. Shop Drawings: Submit shop drawings indicating material characteristics, details of construction, connections, and relationship with adjacent construction.
- C. Product Data: Provide data on pipe materials, pipe fittings, valves and accessories.
- D. Project Record Documents: Record actual locations of piping mains, valves, connections, thrust restraints, and invert elevations. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.3 QUALITY ASSURANCE

- A. Comply with governing codes and regulations. Provide products of acceptable manufacturers which have been in satisfactory use in similar service for three years. Use experienced installers. Deliver, handle, and store materials in accordance with manufacturer's instructions.
- B. Testing: Hydrostatic tests at minimum 1-1/2 times working pressure for 2 hours.

PART 2 – PRODUCTS

2.1 MATERIALS

- A. Ductile Iron Pipe 4 Inches and Larger: AWWA C151, Class 50 minimum.
 - 1. Lining: AWWA C104, cement mortar, seal coated.
 - 2. Gaskets: AWWA C111.
 - 3. Ductile Iron and Cast Iron Fittings, AWWA C110 or AWWA C153, 250 psi minimum pressure rating; AWWA C104 cement mortar lining; AWWA C111 rubber gaskets.
 - 4. Jackets: AWWA C105 polyethylene jacket.
- C. PVC Pipe 4 Inches and Larger: AWWA C900, Class 150.
 - 1. Gaskets: ASTM F 477, elastomeric seal.

2. PVC Couplings and Fittings: AWWA C900 with ASTM F 477 elastomeric seal gaskets.
 3. Ductile Iron and Cast Iron Fittings: AWWA C110, 250 psi pressure rating; AWWA C104 cement mortar lining; AWWA C111 rubber gaskets.
- D. Copper Water Tube 2 Inches and Smaller: ASTM B 88, Type K seamless, annealed temper; ANSI B16.22 wrought-copper solder-joint copper fittings.
1. Fittings: ASME B16.18, cast copper, or ASME B16.22, wrought copper.
 2. Joints: Compression connection or AWS A5.8, BCuP silver braze.
- E. Polybutylene Pipe 3 Inches and Smaller: AWWA C902, DR 17 barbed insert type brass or bronze fittings.
- F. Polybutylene Pipe 3 Inches and Smaller: ASTM D 2662, SIDR15 barbed insert type brass or bronze fittings.
- G. Polybutylene Tubing 3 Inches and Smaller: ASTM D 2666, SIDR13.5 brass or bronze fittings.
- H. Polyethylene Pipe and Tubing 3 Inches and Smaller: AWWA C901; barbed insert type copper alloy or nylon fittings.
- I. Couplings: ASTM A 126, gray iron sleeve assembly with followers, rubber gaskets, bolts, nuts, and enamel paint finish.
- J. Valves:
1. Nonrising stem gate valves 3 Inches and larger, AWWA C500.
 2. Nonrising stem gate valves 2 inches and smaller, MSS SP-80.
 3. Valve Accessories: Cast-iron valve boxes, curb stops, and service boxes for curb stops.
 4. Tapping sleeve and tapping valve for new connections larger than 2 inches.
 5. Service clamps and corporation stops for new connections 2 inches and smaller.
 6. Manufacturer's name and pressure rating marked on valve body.
 7. Gate Valves Up To 3 Inches (75 mm):
 - a. Brass or Bronze body, non-rising stem, inside screw, single wedge or disc, compression ends, with control rod, post indicator, valve key, and extension box.
 8. Gate Valves 3 Inches (75 mm) and Over:
 - a. AWWA C500, iron body, bronze trim, non-rising stem with square nut, single wedge, flanged ends, control rod, post indicator, valve key, and extension box.
 - b. AWWA C509, iron body, bronze trim, non-rising stem with square nut, single wedge, resilient seat, flanged ends, control rod, post indicator, valve key, and extension box.
 9. Ball Valves Up To 2 Inches (50 mm):
 - a. Brass body, teflon coated brass ball, rubber seats and stem seals, Tee stem pre-drilled for control rod, AWWA inlet end, compression outlet with electrical ground connector, with control rod, valve key, and extension box.

10. Swing Check Valves From 2 Inches to 24 Inches (50 mm to 600 mm):
 - a. AWWA C508, iron body, bronze trim, 45 degree swing disc, renewable disc and seat, flanged ends.
11. Butterfly Valves From 2 Inches to 24 Inches (50 mm to 600 mm):
 - a. AWWA C504, iron body, bronze disc, resilient replaceable seat, water or lug ends, ten position lever handle.
- K. Anchorages:
 1. Clamps, Straps, and Washers: ASTM A 506, steel.
 2. Rods: ASTM A 575, steel.
 3. Rod Couplings: ASTM A 197, malleable iron.
 4. Bolts: ASTM A 307, steel.
 5. Cast-Iron Washers: ASTM A 126, gray iron.
 6. Concrete Reaction Backing: ASTM C 150, Type I Portland cement for 3000 psi, 28 day minimum compressive strength.
- L. Valve Pits and Meter Pits: Reinforced concrete with ladder and cast-iron manhole frame and cover.
- M. Water Meter: Utility company water meter.
- N. Meter Box: Cast-iron body and cover with lettering.
- O. Identification: Metallic-lined plastic underground warning tapes.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install materials and systems in accordance with manufacturer's instructions and approved submittals. Install materials and systems in proper relation with adjacent construction. Coordinate with work of other sections.
- B. Clean and disinfect system. Test for proper operation. Backfill and protect work from damage.

3.2 INSTALLATION - PIPE

- A. Install pipe to indicated elevation to within tolerance of 5/8 inches (20 mm).
- B. Install ductile iron piping and fittings to AWWA C600.
- C. Install grooved and shouldered pipe joints to AWWA C606.
- D. Route pipe in straight line.
- E. Install pipe to allow for expansion and contraction without stressing pipe or joints.

3.3 INSTALLATION - VALVES AND HYDRANTS

- A. Set valves on solid bearing.
- B. Center and plumb valve box over valve. Set box cover flush with finished grade.

- C. Set hydrants plumb; locate pumper nozzle perpendicular to and facing roadway.
- D. Set hydrants to grade, with nozzles at least 20 inches (500 mm) above ground.
- E. Locate control valve 4 inches (100 mm) away from hydrant.
- F. Provide a drainage pit 36 inches (900 mm) square by 24 inches (600 mm) deep filled with 2 inches (50 mm) washed gravel. Encase elbow of hydrant in gravel to 6 inches (150 mm) above drain opening. Do not connect drain opening to sewer.
- G. Paint hydrants in accordance with Section 09 9000.

3.4 SERVICE CONNECTIONS

- A. Provide water service to utility company requirements with reduced pressure backflow preventer and water meter with by-pass valves and sand strainer.
- B. Provide sleeve in retaining wall for service main. Support with reinforced concrete bridge. Calk enlarged sleeve watertight.
- C. Anchor service main to interior surface of foundation wall.
- D. Provide 18 gage (1.2 mm) galvanized sheet metal sleeve surrounding service main to 6 inches (150 mm) above floor and 6 feet (1,800 mm) minimum below grade. Size for 2 inches (50 mm) minimum of glass fiber insulation stuffing.

END OF SECTION

SECTION 333000

SANITARY SEWERAGE

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide the following:
 - 1. Sanitary sewerage system.
 - 2. Force main.

1.2 SUBMITTALS

- A. Product Data: Submit manufacturer's product data and installation instructions for each material and product used.
- B. Shop Drawings: Submit shop drawings indicating material characteristics, details of construction, connections, and relationship with adjacent construction.
- C. Shop drawings shall be prepared and stamped by a qualified engineer licensed in the jurisdiction of the project.
- D. Manufacturer's Installation Instructions: Indicate special procedures required to install Products specified.
- E. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- F. Project Record Documents:
 - 1. Record location of pipe runs, connections, catch basins, cleanouts, and invert elevations.
 - 2. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.3 QUALITY ASSURANCE

- A. Comply with governing codes and regulations. Provide products from acceptable manufacturers which have been in satisfactory use in similar service for three years. Use experienced installers. Deliver, handle, and store materials in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Pipe and Fittings:

1. Hub and Spigot Cast-Iron Soil Pipe and Fittings: ASTM A 74, grey cast iron for compression gasket joints, class of service as required.
2. Hubless Cast-Iron Soil Pipe and Fittings: CISPI 301 grey cast iron for coupling joints.
3. Ductile Iron Pressure Pipe: AWWA C151, Class 150 for push-on joints.
4. Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings: ASTM D 2751, for solvent-cemented or gasketed joints.
5. Corrugated Polyethylene (PE) Drainage Tubing and Fittings: AASHTO M 252 Interim, Type S, with smooth waterway for coupling joints.
6. Polyvinyl Chloride (PVC), Sewer Pipe and Fittings: ASTM F 679, T-1 wall thickness, bell and spigot for gasketed joints.
7. Polyvinyl Chloride (PVC), Profile, Gravity Sewer Pipe and Fittings: ASTM F 794, open and closed profile, bell and spigot for gasketed joints.
8. Cast and Ductile-Iron Pipe Encasement: AWWA C105, polyethylene film tube.
9. Couplings: Rubber or elastomeric sleeve and stainless-steel band.
10. Couplings: Rubber or elastomeric compression gasket.
11. Gaskets: Compatible with pipe materials joined.

B. Manholes:

1. Precast Concrete Manholes: ASTM C 478.
2. Cast-In-Place Concrete Manholes: 3000 psi.
3. Manhole Steps: Ductile iron or cast aluminum.
4. Manhole Frames and Covers: ASTM A 536, Grade 60-40-18, heavy-duty ductile iron with lettering.

C. Cleanouts:

1. Cast-iron.
2. PVC with cast-iron adapter.
3. Lid and Frame: Cast iron construction, hinged lid. :
4. Lid Design: Open checkerboard grill.
5. Nominal Lid and Frame Size: 26 inches (660 mm).
6. Shaft Construction and Concentric Cone Top Section: Reinforced precast Concrete pipe sections, lipped male/female dry joints, cast steel ladder rungs into shaft sections at 12 inches (300 mm); nominal shaft diameter of 36 inches (900 mm).
7. Base Pad: Cast-in-place concrete of type specified in Section 03 3000, levelled top surface to receive concrete shaft sections, sleeved to receive sanitary sewer pipe sections.

D. Catch Basins for Storm Sewerage System:

1. Precast Concrete Catch Basins: ASTM C 478 or ASTM C 858.

2. Brick Catch Basins: ASTM C 32, Grade MS manhole brick; ASTM C 270, Type S mortar, and parging.
 3. Cast-In-Place Concrete Catch Basins: 3000 psi.
 4. Catch Basin Steps: Ductile iron or cast aluminum.
 5. Catch Basin Frames and Grates: ASTM A 536, Grade 60-40-18, heavy-duty ductile iron.
 6. Curb Inlets: Precast concrete, stone, or brick conforming to utility standards.
- E. Identification: Metallic-core plastic underground warning tapes.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install materials and systems in accordance with manufacturer's instructions and approved submittals. Install materials and systems in proper relation with adjacent construction. Coordinate with work of other sections.
- B. Where connections are made to existing systems, rout out old drainage lines.
- C. Test for proper operation. Clean and protect work from damage.
- D. Install metallic-core plastic underground warning tape, if required by governing authorities.
- E. Verify that trench cut is ready to receive work and excavations, dimensions, and elevations are as indicated on layout drawings.
- F. Install pipe, fittings, and accessories in accordance with manufacturer's instructions. Seal watertight.
 1. Clay Pipe: Also comply with ASTM C 12.
 2. Plastic Pipe: Also comply with ASTM D 2321.
- G. Lay pipe to slope gradients noted on layout drawings; with maximum variation from true slope of 1/8 inch (3 mm) in 10 feet (3 m).
- H. Connect to building sanitary sewer outlet and municipal sewer system, through installed sleeves.
- I. Install trace wire 6 inches (150 mm) above top of pipe; coordinate with Section 31 2316.13.

3.2 INSTALLATION - CLEANOUTS

- A. Form bottom of excavation clean and smooth to correct elevation.
- B. Form and place cast-in-place concrete base pad, with provision for sanitary sewer pipe end sections.
- C. Establish elevations and pipe inverts for inlets and outlets as indicated.

D. Mount lid and frame level in grout, secured to top cone section to elevation indicated.

3.3 PROTECTION

A. Protect pipe and bedding cover from damage or displacement until backfilling operation is in progress.

END OF SECTION

SECTION 334000

STORM DRAINAGE

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide the following storm drainage systems:
 - 1. Provide storm drainage piping.
 - 2. Provide manholes and installation of manhole frames, covers and steps.
 - 3. Provide catch basins and installation of catch basin frames and grates.
 - 4. Provide exterior trench drain system.
 - 5. Provide oil/water separators.

1.2 SUBMITTALS

- A. Shop Drawings: Submit shop drawings and manufacturer's specifications and installation instructions for precast modular trench drain units, oil/water separators and geotextile fabrics in accordance with Section 013300.
- B. Project Record Documents:
 - a. Record location of pipe runs, connections, catch basins, cleanouts, and invert elevations.
 - b. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.3 QUALITY ASSURANCE

None

PART 2-PRODUCTS

2.1 PIPE MATERIALS

- A. General: Ells, tees, reducing tees, wyes, couplings, increasers, crosses, transitions and end caps of same type and class of material as piping unless otherwise indicated.
- B. Reinforced Concrete Pipe: ASTM C76, Class III; modified tongue-and-groove compression gasket joints complying with ASTM C443. Reinforced, ASTM C 76 (ASTM C 76M), Class II with Wall type A; mesh reinforcement
- C. Corrugated Metal Pipe: AASHTO M36; helically or circumferentially corrugated; minimum 16 gage mill galvanized steel; coupling band joints.
- D. PVC Plastic Pipe: ASTM D3034, Type PSM, SDR 35; bell-and-spigot type joints with ASTM D2564 joint solvent cement.

- E. Corrugated Polyethylene Pipe: AASHTO M252 or M294; split or screw-on, corrugated fittings.
- F. Cast Iron Soil Pipe: ASTM A 74, Extra Heavy grade,
- G. Cast Iron Pipe Joint Device: ASTM C 564, rubber gasket joint devices.
- H. Vitrified Clay Pipe: ASTM C 700, Extra strength, unperforated;
- I. Vitrified Clay Pipe Joint Device: ASTM C 425 compression gasket joint.
- J. Concrete Pipe: Nonreinforced, ASTM C 14 (ASTM C 14M), Class 1;
- K. Concrete Pipe Joint Devices: ASTM C 443 (ASTM C 443M) rubber compression gasket joint.
- L. Reinforced Concrete Pipe Joint Device: ASTM C 443 (ASTM C 443M) rubber compression gasket joint.
- M. Coupling Bands: Galvanized steel, 0.052 inches (1.3 mm) thick x 10 inches (250 mm) wide; connected with two neoprene "O" ring gaskets and two galvanized steel bolts.

2.2 PRECAST MODULAR MATERIALS

- A. Concrete: As specified in Section 033000, unless otherwise indicated.
- B. Precast Concrete Manholes: ASTM C478, eccentric cone precast top; precast base riser section with integral floor.
- C. Precast Trench Drain System:
 - 1. Acceptable Manufacturers: ACO Polymer Products, Inc., ABT, Inc. (PolyDrain), Polycast Drain Div. of Quazite Corp., Riverside Steel.
 - 2. General: Interlocking modular channel units constructed of precast polymer concrete, frame and gratings; uniform built-in slope in each unit of minimum 0.6 percent, radiused bottoms; 6.0 to 6.1 inches channel width, minimum 5.0 inches channel depth.
 - 3. Frame and Gratings: Separate cast iron frame integrally bonded to channel unit; cast iron grating with lockdown device.
 - 4. Channel End Caps: Of same material as channel units.
- D. Presloped Trench Drain System:
 - 1. Acceptable Manufacturers: Zurn Industries, Inc., Hydromechanics Div., Composite Concepts, Inc – Aqueduct, or approved equal.
 - 2. General: Interlocking modular channel units, frame and gratings; uniform built-in slope in each unit of minimum 0.6 percent, radiused bottoms; 6.0 to 6.1 inches channel width, minimum 5.0 inches channel depth.
 - 3. Frame and Gratings: Separate cast iron frame integrally bonded to channel unit; cast iron grating with lockdown device.
 - 4. Channel End Caps: Of same material as channel units.
- A. Precast Oil/Water Separator

1. General: Watertight unit, sized as indicated on the drawings. Set the top of clean out frames and covers 2 inches above finish grade. Manufacturer, quality of the units and installation details must comply with Building Departments' requirements.
 2. Unit is to be designed for H20 loading if in main drive isle and H10 loading if located outside of main drive aisle. Design loading designation will be indicated on the submittal from manufacturer.
- E. Pipe Accessories
1. Pipe Joints: Mechanical clamp ring type, stainless steel expanding and contracting sleeve, neoprene ribbed gasket for positive seal.
 2. Fittings: Same material as pipe molded or formed to suit pipe size and end design, in required tee, bends, elbows, cleanouts, reducers, traps and other configurations required.
 3. Filter Fabric: Non-biodegradable, woven,
 4. Trace Wire: Magnetic detectable conductor, clear plastic covering, imprinted with "Storm Sewer Service" in large letters.

2.3 MASONRY MATERIALS

- A. Concrete Masonry Units: ASTM C139.
- B. Brick: ASTM C32, Grade MS or ASTM C62, Grade SW.
- C. Mortar: ASTM C270, Type M.

PART 3-EXECUTION

3.1 PIPING INSTALLATION

- A. Lay piping true to grades and alignment indicated with unbroken continuity of invert.
- B. Lay piping by proceeding upgrade. Place groove ends of tongue-and-groove pipe pointing upgrade.
- C. Clear piping interior of dirt and other superfluous material as work progresses.
- D. Place plugs in ends of incomplete piping at end of workday or whenever work stops.
- E. Install pipe, fittings, and accessories in accordance with manufacturer's instructions. Seal watertight.
 1. Plastic Pipe: Also comply with ASTM D 2321.
- F. Lay pipe to slope gradients noted on layout drawings; with maximum variation from true slope of 1/8 inch (3 mm) in 10 feet (3 m).
- G. Install continuous trace wire 6 inches (150 mm) above top of pipe.

3.2 CONCRETE DRAINAGE STRUCTURES

- A. Perform concrete work for manholes, catch basins and trench drains as specified in Section 033000, unless otherwise indicated.
- B. Integrally cast manhole steps into manhole sidewalls.
- C. Set tops of manhole frames and covers and catch basin frames and grates flush with finish surface in paved areas. Elsewhere, set tops 3 inches above finish surface.
- D. Install precast modular trench drain units in accordance with manufacturer's installation instructions.

END OF SECTION

SECTION 400506

PIPING SPECIALTIES

PART 1 - GENERAL

1.01 SCOPE OF WORK:

- A. This Section specifies the basic administrative and testing requirements for piping.
- B. The items shall include the following:
 - 1. Unions
 - 2. Dielectric Connectors
 - 3. Plugs and Caps
 - 4. Miscellaneous Adaptors
 - 5. Vents and Drains
 - 6. Line Strainer
 - 7. Service Clamps
 - 8. Clean-outs
 - 9. Floor Drains
 - 10. Quick Connect Couplings
 - 11. Mechanical Sleeve Seals
 - 12. Flexible Connectors
 - a. Sleeve Couplings
 - b. Split or Grooved Couplings
 - c. Flange Adapters
 - d. Pump and Equipment Flexible Connectors

- e. Flexible Connectors
- 13. Expansion Joints
 - a. Single- and Multiple- Arch Type
 - b. Bellows Style
 - c. Flexible Metal Hose
- 14. Harnessing and Restraints
- 15. Pressure Gauges
- 16. Diaphragm Seals for Gages
- 17. Pipe Cleaning Equipment
- 18. Spray Nozzles
- 19. Appurtenances and Miscellaneous Items
- 20. Color Coding and Labeling

1.02 RELATED WORK:

- A. Piping materials and systems are included in other Sections of Division 400500.
- B. Valves are included in Section 400562.

1.03 SUBMITTALS:

- A. General submittals for piping, piping systems and pipeline appurtenances are listed below. Submittals shall be in accordance with Sections 400510. It is not intended that all submittals listed below be provided for all piping materials and systems. Refer to individual System or Piping Sections for specific submittals.
- B. Shop Drawings and Product Data
 - 1. Piping layouts in full detail.
 - 2. Location of pipe hangers and supports.
 - 3. Location and type of backup block or device to prevent joint separation.
 - 4. Large scale details of wall penetrations and fabricated fittings.

5. Schedules of all pipe, fittings, special castings, couplings, expansion joints and other appurtenances.
 6. Catalog cuts of joints, couplings, harnesses, expansion joints, gaskets, fasteners and other accessories.
 7. Catalog cuts of all pipeline appurtenances specified herein.
 8. Brochures and technical data on coatings and linings and proposed method for application and repair.
- C. Samples
- D. Design Data
- E. Test Reports
1. Three copies of certified shop tests showing compliance with appropriate standard.
 2. Three copies of all field test reports, signed by Contractor.
- F. Certificates
1. Copies of certification for all welders performing work in accordance with ANSI B31.1.
- G. Manufacturers Installation (or application) instructions.
- H. Statement of Qualifications
- I. Manufacturers Field Report
- J. Project Record Document
- K. Operation and Maintenance Data.
- L. Warranties

1.04 REFERENCE STANDARDS:

- A. American Society for Testing and Materials (ASTM)
1. ASTM A36 - Standard Specification for Carbon Structural Steel.

2. ASTM A126 - Standard Specification for Gray Iron Casting for Valves, Flanges and Pipe Fittings.
3. ASTM A183 - Standard Specification for Carbon Steel Track Bolts and Nuts.
4. ASTM A278 - Standard Specification for Gray Iron Castings for Pressure-Containing Parts for Temperatures up to 650 Degrees F.
5. ASTM A307 - Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
6. ASTM A325 - Standard Specification for Strength Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
7. ASTM A536 - Standard Specification for Ductile Iron Castings
8. ASTM A575 - Standard Specification for Steel Bars, Carbon, Merchant Quality, M-Grades.
9. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings.
10. ASTM B88 - Standard Specification for Seamless Copper Water Tube.

B. American National Standards Institute (ANSI)

1. ANSI A13.1 - Scheme for the Identification of Piping Systems.
2. ANSI B1.1 - Unified Inch Screw Threads (UN and UNR Thread Form)
3. ANSI B18.2 - Square and Hex Bolts and Screws Inch Series Including Hex Cap Screws and Lag Screws.
4. ANSI B31 - Code for Pressure Piping, B31 Interpretation.
5. ANSI B31.1 - Power Piping

C. American Society of Mechanical Engineers (ASME)

1. ASME B2.1 - Specifications, Dimensions, Gauging for Taper and Straight Pipe Threads (except dry seals).
2. ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250 and 800.

3. ASME B16.5 - Pipe Flanges and Flange Fittings
- D. American Welding Society (AWS)
1. AWS B3.0 - Welding Procedure and Performance Qualifications
- E. American Water Works Association (AWWA)
1. AWWA C110 - Ductile-Iron and Gray-Iron Fittings, 3-inch Through 48-inch (75mm Through 1200mm), for Water and Other Liquids.
 2. AWWA C111 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
 3. AWWA C200 - Steel Water Pipe 6-in and Larger.
 4. AWWA C606 - Grooved and Shouldered Type Joints.
 5. AWWA Manual M11 - Steel Pipe - A Guide for Design and Installation.
- F. Plumbing and Drainage Institute (PDI)
1. WH 201 - Water Hammer Arrestors
- G. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 QUALITY ASSURANCE:

- A. All materials shall be new and unused.
- B. Install piping to meet requirements of local codes.
- C. Provide manufacturer's certification that materials meet or exceed minimum requirements as specified.
- D. Coordinate dimensions and drilling of flanges with flanges for valves, pumps and other equipment to be installed in piping systems. Bolt holes in flanges to straddle vertical centerline.
- E. Reject materials contaminated with gasoline, lubricating oil, liquid or gaseous fuel, aromatic compounds, paint solvent, paint thinner and acid solder.
- F. Pipe-joint compound, for pipe carrying flammable or toxic gas, must bear approval of Underwriters' Laboratories or Factory Mutual Engineering Division.

- G. Unless otherwise specified, pressures referred to in all Piping Sections are expressed in pounds per square inch (gage) above atmospheric pressure, psig, and all temperature are expressed in degrees Fahrenheit.

1.06 DELIVERY, STORAGE AND HANDLING:

- A. During loading, transportation and unloading, take care to prevent damage to pipes and coating. Carefully load and unload each pipe under control at all times. Place skids or blocks under each pipe in the shop and securely wedge pipe during transportation to ensure no injury to pipe and lining. Cover or cap all pipe ends while pipe is in storage, until it is made a part of the work.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT:

- A. Specific piping materials and appurtenances are specified in the respective Piping or System Sections. The use of a manufacturer's name and/or model number is for the purpose of establishing the standard of quality and general configuration desired.
- B. Equipment shall be of the size shown on the Drawings or as noted and as far as possible equipment of the same type shall be identical and from one manufacturer.
- C. Equipment shall have the name of the maker, nominal size, flow directional arrows (if applicable), working pressure for which they are designed and standard referenced specifications cast in raised letters or indelibly marked upon some appropriate part of the body.
- D. Unless otherwise noted, items shall have a minimum working pressure of 150 psi or be of the same working pressure as the pipe they connect to, whichever is higher and suitable for the pressures noted where they are installed.

2.02 UNIONS:

- A. Unions shall be brass or bronze unions for joining nonferrous pipe; malleable brass or bronze-seated iron or steel unions for joining ferrous pipe; PVC unions for joining PVC pipe; CPVC unions for joining CPVC pipe.

2.03 FLANGED JOINTS:

- A. Flanged Joints. Bolt and nuts, Type 304 or 316 stainless steel, bolt number and size same as flange standard; studs - same quality as machine bolts; 1/16-inch thick rubber gaskets with cloth insertions; rust-resistant coatings.

2.04 DIELECTRIC CONNECTORS:

- A. Dielectric pipe fittings/insulators and unions shall be used to prevent galvanic action wherever valves or piping of dissimilar metals connect. This shall be particularly the case for copper, brass and bronze piping connecting to cast iron or steel piping systems.
- B. Dielectric unions shall be used for 2-inch and smaller connections. Steel union nuts shall meet ASTM A575 requirements. The steel or ductile iron connection end shall have a steel body and shall have accurately machined taper tapped pipe threads in accordance with ASME B2.1. The copper connection end shall be a copper solder joint that meets requirements of ASTM B88. Dielectric unions shall be rated for at least 250 psi at 210 degrees F.
- C. Dielectric flange unions shall be used for connections 2½-inch and larger. Cast iron flanges shall meet ASTM A126; the copper solder end shall meet ASTM B62 and the pipe thread shall meet ASME B2.1. Dielectric flange unions shall be rated for at least 175 psi at 210 degrees F.
- D. Dielectric unions and flange unions shall be as manufactured by Epco Inc., Cleveland, OH or approved equal.
- E. Flange insulating kits shall be as acceptable to the Engineer, as manufactured by PSI or approved equal.
- F. Insulated sleeve couplings and flange adaptors shall be similar to those units as specified elsewhere.

2.05 PLUGS AND CAPS:

- A. Provide standard plug or cap as required for testing; plugs, caps suitable for permanent service.
- B. Plug or cap or otherwise cover all piping work in progress.

2.06 MISCELLANEOUS ADAPTORS:

- A. Between different types of pipe and/or fittings special adaptors may be required to provide proper connection. Some of these may be indicated on the Drawings or specified with individual types of pipe or equipment. However, it is the

Contractor's responsibility to ensure proper connection between various types of pipe, to structures and between pipe and valves, gates, fittings and other appurtenances. The Contractor shall provide all adapters as required, whether specifically noted or not.

- B. As required, these adapters shall be suitable for direct bury, with proper dielectric insulation and as a minimum, if metallic (not stainless steel or galvanized), with two coats of Coal Tar Epoxy.

2.07 VENTS AND DRAINS:

- A. ½-inch vents shall be provided at the high point in each system. Vent connections may be tapped, provided the tap will accept three full threads on the bronze nipple.
- B. 1½-inch drains shall be provided to permit drainage of each system located on the invert of the blind flange; provide hose-end valve.

2.08 LINE STRAINERS:

- A. Manual Duplex Basket Strainer
 - 1. Manual duplex basket strainers shall be furnished for pipe diameters 2-inches in diameter and larger, as shown on the Drawings. The strainer body shall be of cast iron construction. The strainer elements, including woven wire screen, shall be constructed of Type 304 stainless steel. The design of the basket strainer body shall be such that the basket may be easily removed for inspection and cleaning while piping remains online.
 - 2. A trap with a blow-off port shall be provided for removing any material that may settle at the bottom. The strainers shall be designed for a maximum operating pressure of 150 psig, and shall be manufactured by Hayward or approved equal.
 - 3. Proper blowoff piping with valve shall be supplied and run to nearest drain.

2.09 SERVICE CLAMPS:

- A. Service clamps for outlet sizes up to 2-inches shall have malleable or ductile iron bodies which extend at least 160 degrees around the circumference of the pipe and shall have neoprene gaskets cemented to the saddle body. Bodies shall be tapped for IPS. Clamps shall be of the double strap design. Service clamps shall be Style 91 as manufactured by Dresser Industries, Inc. or approved equal as manufactured by Smith Blair; Mueller or equal.

- B. Service clamps for outlet sizes 4-inch through 12-inch where the outlet size is not greater than half the size of the main pipe shall have ductile iron bodies and a neoprene circular cross section O-ring gasket confined within the body. Outlet shall be AWWA C110 flange or AWWA C111 mechanical joint as required for the application. Straps shall be alloy steel, minimum ¼-inch by 1½-inch in cross section and fabricated with ¾-inch threaded ends. Service clamps shall be Fig. A-10920 or A-30920 as manufactured by American Cast Iron Pipe Company or approved equal.

2.10 CLEAN-OUTS:

- A. Interior flush floor clean-outs shall consist of a coated cast iron ferrule, a tapered threaded bronze clean-out plug, adjustable housing and a scoriated round cast iron tractor cover with bronze top. Interior flush floor clean-outs shall be Type No. 56056 as manufactured by Josam Manufacturing Co., Michigan City, IN, similar models by Tyler, or approved equal.
- B. Exterior clean-outs shall consist of a coated cast iron ferrule with cut-off sections, a tapered threaded bronze clean-out plug, Josam 58486 or equal, with a heavy round coated cast iron access frame with anchor flanges and a gasketed cover, Josam Type No. 58680, similar models by Tyler or approved equal. Exterior clean-outs shall be installed as noted on the Drawings.
- C. Clean-outs shall be located where shown on the Drawings.
- D. Clean-out connections to 6-inch cast iron bell and spigot soil pipe and clean-out connections to 6-inch ductile iron bell and spigot pipe shall be caulked.

2.11 FLOOR DRAINS:

- A. Floor drains shall have 8-in square, adjustable, bronze top strainers and coated cast iron bodies.
- B. Floor drains shall have outlet connections for 4-inch cast iron bell and spigot soil pipe except where required by other type pipe and/or indicated on the Drawings. They shall be Series No. 30004-8S as manufactured by Josam, approved equal by Tyler or equal.

2.12 QUICK CONNECT COUPLINGS:

- A. Couplings shall be of the cam and groove type consisting of a male adapter conforming to Specification MIL-C-27487. Male adapters shall be designed to receive a female coupler without requiring threading, bolting, or tools. Connections shall remain tight and leakproof under pressures up to 100 psig. Each adapter shall be furnished with a dust cap complete with a 18-inch long security chain of corrosion resistant material. Couplings shall be as manufactured

by Dover Corporation; Ever-tite, or approved equal. Units shall be "drip proof", providing totally dry connections and disconnections.

- B. Adapters shall be furnished in accordance with the Drawings, or as required by the installation.

2.13 MECHANICAL SLEEVE SEALS:

- A. Mechanical sleeve seals shall be used to secure and seal the annular space around all new sleeved and core-drilled wall penetrations.
- B. A single seal shall be provided for all sleeve and cores in walls up to 14-inches thick; dual sleeves shall be provided in larger walls.
- C. Galvanized steel wall sleeves and concrete core diameter shall be sized sufficiently larger to accommodate the modular elements, per the manufacturers recommendations.
- D. Bolts and hardware shall be carbon steel, zinc-plated. Pressure plates shall be corrosion-resistant acetal resin.
- E. Mechanical sleeve seals shall consist of modular bolted, synthetic rubber sealing elements, Link Seal, manufactured by Thunderline Corp., or approved equal.

2.14 FLEXIBLE CONNECTORS:

- A. Sleeve Couplings
 - 1. Provide plain end type ends to be joined by sleeve couplings as stipulated in AWWA C201.
 - a. Join welds on ends by couplings without pipe stops. Grind flush to permit slipping coupling in at least one direction to clear pipe joint.
 - b. Outside diameter and out-of-round tolerances shall be within limits specified by coupling manufacturer.
 - c. Provide lugs in accordance with ASTM A36.
 - d. Provide hardened steel washers in accordance with ASTM A325.
 - e. Plastic plugs shall be fitted in coupling to protect bolt holes.
 - f. Nuts and bolts

- 1) Provide bolts and bolt-studs in accordance with ASTM A307 and ANSI B1.1 with hexagonal or square heads, coarse thread fit, threaded full length with ends chamfered or rounded.
 - 2) Project ends 1/4-inch beyond surface of nuts.
 - 3) Hexagonal nuts with dimensions in accordance with ANSI B18.2 and coarse threads in accordance with ANSI B1.1.
2. Middle ring of each mechanical coupling shall have a thickness at least equal to that specified for size of pipe on which coupling is to be used and shall not be less than 10-inches long for pipe 30-inches and larger and not less than 7-inches long for pipe under 30-inches in diameter.
 - a. Omit pipe stop from inner surface of middle rings of couplings whenever necessary to permit removal of valves, flowmeters and other installed equipment.
 - b. Provide pipe stops in other couplings.
 3. Clean and shop prime with manufacturer's standard rust inhibitive primer.
 4. Furnish gaskets of a composition suitable for exposure to the fluid service.
 5. Where shown on the Drawings, anchor sleeve-coupled joints with harness bolts. Weld harness lugs to steel pipe.
 - a. Joint harness bolts shall be of sufficient length, with harness lugs placed so that coupling can be slipped at least in one direction to clear joint. Provide harnesses of sufficient number and strength to withstand test pressure.
 - b. Each harness shall have a minimum of two 5/8-inch diameter bolts.
 6. Unless otherwise specified with the individual type of pipe, sleeve couplings (mechanical couplings) shall be ITT (formerly Smith Blair) Style 411; Dresser Style 38, similar models by Baker or approved equal, with the pipe stop removed.
 7. Similar insulation type couplings shall be provided at the face of buildings, between different type metals or where otherwise noted.
 8. In addition to those locations noted on the Drawings, sleeve couplings shall be provided on all piping where it connects with a structure or buried directly under a structure at the structure's expansion joints. Special

treatment will be required where pipe is encased in concrete, utilizing minimum 3-inch thick styrofoam placed perpendicular to the horizontal centerline of the coupling.

B. Split or Grooved Couplings

1. Split couplings shall be cast in two or more parts. When secured together with ASTM A183 bolts and nuts, couplings shall engage grooved or shouldered pipe ends and encase an elastomeric gasket to create a pipe seal. Gasket material shall be as recommended by the manufacturer for the service required.
2. Split couplings shall be as manufactured by Victaulic Company of America; Gustin-Bacon or approved equal. Numbers below refer to Victaulic Co. items, for reference only.
3. Unless otherwise specified with the individual type of pipe:
 - a. Flexible split ring couplings shall be:
 - 1) grooved ends - Style 77
 - 2) shouldered ends - Style 44
 - b. Rigid split ring couplings shall be:
 - 1) grooved ends - rigid groove with Style HP-70 couplings on ductile iron less than 18-inch diameter with sufficient wall thickness per AWWA C606, on standard groove with Style 77 coupling on manufactured steel or other pipe.
 - 2) shouldered ends - Style 44 coupling on ductile iron over 16-inch diameter or without sufficient wall thickness per AWWA C606 or on manufactured steel pipe or thin wall stainless steel pipe.
4. Ductile iron pipe for use with split-type coupling joints shall have radius grooved ends conforming to AWWA C606. Pipe shall have grooved ends to provide either a rigid joint or flexible joint as shown on the Drawings and as specified herein. Flexible joint grooving shall permit expansion and contraction, and angular deflection. Rigid joint grooving shall allow no angular or linear movement. Minimum pipe wall thickness for grooved pipe shall be the following class:

Size	Class
4 thru 16	53
18	54
20	55
24	56

5. Grooved couplings for steel and stainless steel piping shall have roll grooving, machine-grooving, or ring collars fully welded to the pipe or fitting.
6. Rigid split couplings may be substituted for flanges as noted on the Drawings and in the individual pipe specifications.
7. Certain minimum thickness of pipe walls are required by AWWA C606 and coupling manufacturers for use of various type split couplings with certain pipes. The Contractor shall be responsible for utilizing at least those minimum wall thicknesses required (unless a greater thickness is specified or required in the individual pipe specifications) with split couplings.
8. If minimum thicknesses are not utilized with grooving, then a shouldered end treatment with couplings as noted shall be utilized.

C. Flanged Adaptors

1. Flanged adaptor connections for grooved or shouldered end pipe compatible with split couplings at fittings, valves and equipment shall be VIC-Flange Style 341 as manufactured by the Victaulic Company of America, or approved equal product as manufactured by Gustin-Bacon.
2. Flanged adaptor connections for plain end pipe at fittings, valves and equipment shall be Dresser Style 127 or 128, similar models by ITT (formerly Smith-Blair); Baker or approved equal.

D. Pump and Equipment Flexible Connectors

1. The flexible connectors shall be expansion/vibration joints of the single arch type of butyl rubber construction with carcass of high grade woven cotton or suitable synthetic fiber and individual solid steel ring reinforcement. Soft rubber fillers shall be integrally cured into the arches to provide a smooth flow path to prevent settling of material into the arch. Joints shall be constructed to pipeline size and to meet working pressures

and corrosive conditions similar to the line where installed. Joints shall have full faced fabric reinforced butyl flanges integral with the body.

2. Split steel or ductile iron back-up rings shall be provided to insure a good joint. Rings shall be designed for mating with ANSI Standard minimum 150 lb flanges. All joints shall be finish coated with Hypalon, or approved equal paint.
3. Expansion/vibration joints shall be furnished with control (harness) units. Harness units shall consist of minimum two drilled plates, stretcher bolts, and rubber washers backed by metal washers. The stretcher bolts shall prevent over-elongation of the joint. Extra nuts shall be provided on the stretcher bolts on the inside of the plate to prevent overcompression. All nuts, bolts and plates shall be galvanized.
4. The manufacturer of the expansion joints shall be a member of the Rubber Expansion Joint Division of the Fluid Sealing Association. Expansion joints shall be Style 1025 filled arch as manufactured by General Rubber Corp., South Hackensack, NJ or similar products of Mercer Rubber; Goodall Rubber; Garloc; Proco Products Inc., Stockton, CA or approved equal.
5. In addition to other locations shown on the Drawings, expansion joints shall be utilized in all exposed piping, within one foot of a building expansion joint, and on the suction and discharge side of all positive displacement pumps, compressors and rotating machinery, as close to the unit as possible.

E. Flexible Connectors

1. Provide one flexible connector for the seal water connection to each pump stuffing box. Connectors shall be of hose of Buna-N or similar resilient material, with fiber reinforcement, rated minimum 150 psi with bronze or Type 304 stainless steel NPT end fittings and shall be 12-inches in length. Connectors shall be for the purpose of isolating pump vibration from the seal water piping.

2.15 EXPANSION JOINTS:

A. Single- and Multiple-Arch Type

1. The expansion joints shall be of the rubber spool type, soft rubber filled with single-, double-, or triple-arch steel reinforced expansion joint, as indicated on the Drawings, suitable for 120 degrees F service, unless otherwise indicated.

2. The rubber used shall be suited for service with wastewater and/or wastewater sludge, including three-ply abrasion resistant liner.
3. Provide galvanized retaining rings to mate with adjacent pipe flanges.
4. The expansion joints shall be designed for the axial movements shown on the Drawings along with the maximum axial force required to compress the joint. The joints shall prevent axial, lateral and rotational movement and vibration from being transmitted to the piping and equipment and shall be suitable for 50 psig operating pressure unless otherwise indicated.
5. Provide guides for each expansion joint.

B. Bellows Style

1. Expansion joints shall be hydraulically formed (with dies on the outside only) and having only longitudinal seam welds. These seams shall have the same strength, physical properties and thickness as the parent metal without grinding. Expansion joints, bellow, and internal sleeves shall be made of Type 304 stainless steel with carbon steel flanges at each end. The entire inside length of the expansion joint shall be straight. Manufacturer to provide lifting lugs at each flange for ease in handling and removal sheet metal coverage for any expansion joint.
2. Expansion joints shall be designed to prevent rotational movement and vibration from being transmitted to the piping and equipment and shall be suitable for 25 psig operation pressure unless otherwise specified.
3. Expansion joints shall be suitable for continuous operating temperature range of 200 degrees F to 300 degrees F.
4. Hinged or Gimbal expansion joints shall be used at horizontal and vertical bends in strict accordance with the standards of the EJMA, Inc.
5. Drilling and facing of flanges shall match or be suitable for use with equipment or companion flanges.
6. Guides shall be furnished with all bellows style expansion joints.
7. Manufacturer shall warrant this product to be suitable for the proposed conditions and shall furnish drawings for approval giving materials of construction, including gauge of corrugated element, maximum test pressure force to compress joint, bellows spring rate, shear force and end moment due to calculated traverse only. Manufacturer shall also furnish evidence of completing cycle life testing for the maximum diameter to be

installed and shall indicate such assured cycle life test results on material submitted for approval.

C. Flexible Metal Hose

1. Flexible metal hose shall be constructed of corrugated inner tubing of tin-bronze or Type 321 stainless steel and shall have an outer shield of wire-braid of either tin-bronze or Type 321 stainless steel.
2. The flexible hose connectors shall have a length not less than five times the nominal pipe diameter.
3. The connectors shall have 150 psi flanged ends in all sizes and shall be suitable for pressure up to 150 psig and temperatures to 400 degrees F.
4. Flexible hose connectors shall be manufactured by Flexonics; Metraflex or approved equal.

2.16 HARNESSING AND RESTRAINT:

- A. Where harnessed couplings or adapters are noted, they shall conform to AWWA Manual M11 except as modified by the Drawings or this Specification.
- B. Unless otherwise noted, size and material for tie rods, clamps, plates and hex nuts shall be as shown on the Drawings, or, if not shown on the Drawings, shall be as required in AWWA Manual M11. Manufactured restraining clamp assemblies shall be as manufactured by Stellar Corporation, Columbus, OH, or fabricated approved equal.
- C. Restrained joints (such as welded, locking mechanical joints) shall be of the type specified with the individual type of pipe. If not specified, restrained (locking) mechanical joint pipe shall be of the manufacturer's standard design utilizing a locking device (ring or ears) integrally cast with the pipe.
- D. For up through 18-inch diameter ductile iron pipe only, the following may be used as an alternative to other restraint system:
 1. The optional mechanical joint restraints shall be incorporated in the design of a follower gland. The gland shall be manufactured of ductile iron conforming to ASTM A536. Dimensions of the gland shall be such that it can be used with the standardized mechanical joint bell and tee-head bolts as specified with the pipe.
 2. The restraint mechanism shall consist of numerous individually activated gripping surfaces to maximize restraint capability. The gripping surfaces shall be wedges designed to spread the bearing surfaces on the pipe.

Twist-off nuts, sized same as tee-head bolts, shall be used to insure proper actuating of restraining devices. When the nut is sheared off, standard hex nut shall remain.

3. The mechanical joint restraint device for ductile iron pipe shall have a working pressure of at least 250 pounds per square inch with a minimum safety factor of 2:1.
 4. The mechanical joint restraint devices shall be of the type listed below or approved equal.
 5. For Ductile Iron Pipe: EBAA Iron, Inc. Megalug 1100 series for up to 12-in only.
- E. The Contractor shall be responsible for anchorage including restraint as noted elsewhere in Division 15.

2.17 PRESSURE GAGES:

- A. Bosses, connections, or nipples for gages shall be provided as acceptable to the Engineer. Unbossed tapings shall not be acceptable. Where gage tapings are not available in the suction or discharge nozzle, the necessary tapping in the adjacent piping shall be made.
- B. In addition to the locations shown on the Drawings, pressure gages shall be furnished and installed on the upstream and downstream sides of pressure reducing stations and in the suction and discharge nozzle of all pumps, compressors and similar equipment. Additional pressure gages shall be furnished and installed as specified with individual equipment.
- C. Gages shall be furnished as part of a complete factory assembly, including gage, snubber, liquid fill, bar stock ball valve isolation valve and threaded red brass connecting piping.
- D. Unless otherwise noted, gage rating shall be from 0 to at least 5 percent higher than the rating of the pipe it is connected to.
- E. For Liquid Service
 1. Pressure gages shall have a 300 series stainless steel/ABS or FRP/Aluminum case and shall be 4½-inch nominal diameter with a full-sized Type 316 stainless steel Bourdon tube and a 300 series stainless steel movement. The gages shall be liquid filled with glycerin and shall be provided with a filler/breather cap. The socket shall be ¼-inch NPT Type 316 stainless steel with a bottom connection and the dial shall be a white

background with black markings. Gages shall be ANSI Grade A plus or minus 1 percent of scale and shall have a blow-out back design.

2. Gages for the above services shall be Model 344Y liquid filled as manufactured by Crosby Valve & Gage Co., or by U.S. Gage; Ashcroft or Trerice, or approved equal.

F. Air Service

1. Unless otherwise noted, pressure gages for low pressure air pipelines shall have a range of 0 to 15 psig.
2. Pressure gages shall have a 300 series stainless steel/aluminum case and shall be 4½-inch nominal diameter with a Type 316 stainless steel Bourdon tube and a 300 series stainless steel movement. The socket shall be ½-inch NPT Type 316 stainless steel with a bottom connection. Gages shall have an accuracy of at least plus or minus 0.25 percent (0.25%) of scale. Gages shall be furnished with needle valve isolation.
3. Gages for air service shall be Model 5840 as manufactured by Marsh Instrument Co., Skokie, IL or equal.

- G. Gages shall be furnished from standard ranges of the manufacturer, with dual range (ft and psi) scales.

2.18 DIAPHRAGM SEALS FOR GAGES:

- A. Diaphragm seals shall be installed for all pressure gages and pressure switches not on clean water lines, to protect pressure gages and pressure switches from contact with the fluid in the pipeline. Gages shall be furnished as part of a complete factory assembly, including gage, snubber, diaphragm seal, liquid fill, bar stock isolation valve and threaded red brass interconnecting piping. Furnish also a ½-inch backflushing connection and ball valve.
- B. Diaphragm seals shall be minimum 2½-inch diameter, or as required for the connected pressure gages. The diaphragm shall be "thread attached" to both piping and pressure switches or gages. Furnish mineral oil fill between the diaphragm seal and the gage.
 1. Diaphragm seals shall have an upper housing of cadmium plated carbon steel, with the lower housing of Type 316 stainless steel or material specifically chosen according to the fluid type and pressure being monitored with Type 304 stainless steel bolts. Diaphragms shall be Teflon.
 2. Each diaphragm seal shall be connected to its respective piping or equipment with threaded red brass pipe and fittings. Pipe size and

diaphragm tap size shall match the size of the gage tap on the equipment, but shall not be less than 3/4-inch, except for connections to plant water piping which shall be minimum 1/2-inches. Furnish a ball valve shut-off valve between the pipeline or equipment and the diaphragm seal.

3. Each diaphragm seal shall have a minimum 1/4-inch NPT flush connection with ball valve and gage tap to match the size of the gage.
4. Furnish pulsation dampeners adequate to prevent pulsation and/or vibration of the gage indicator under all system operating conditions.
5. Pump gages shall connect to the diaphragm seal by a flexible Type 304 stainless steel capillary tube. Gages shall be mounted on a support stand independent of the pump and piping, to minimize vibration of the gages caused by vibration of the equipment or piping. Mount both the suction and discharge gages at the same elevation. Furnish supports as specified in Section 400507 or attach gages to the seal water assembly support (where applicable).

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6. Diaphragm seals shall be Type SG by Mansfield and Green, equal by Ashcroft, or approved equal.

- C. Where installed on chlorine lines, or lines leading to chlorine ejectors, seals shall be of special chlorine-resistant type. All other materials shall be certified corrosion resistant for seal location and fluid.
- D. Diaphragm seals for [chemical piping] pressure gages shall be equal to Series 30 threaded-end (1/2-inch to 1-inch diameter piping) or Series 40 wafer flange (1 1/2-inch to 2-inch diameter piping) as manufactured by Red Valve. Body shall be PVC or Type 304 stainless steel with PVC end caps and diaphragms shall be Hypalon.

2.19 PIPE CLEANING EQUIPMENT:

- A. Pipe cleaning equipment shall consist of plastic projectiles ("pigs") and projectile launching vessels ("pig" launchers) suitable for use in cleaning 8-inch diameter pipelines.
- B. "Pigs" shall be cylindrical, with a bullet shaped nose and concave base, covered with a criss-cross pattern of hard rubber strips. Material of construction shall be resilient polyurethane foam with a density of 5 pounds per cubic foot. Furnish four "pigs".
- C. The "pig" launchers shall consist of adequately sized chambers to receive the "pigs". One end of the chamber shall be provided with a reducer and flanged connection for attachment to the pipeline. The other end shall be provided with a

hinged closure piece, using T-bolts for sealing and three 2-inch diameter threaded connections fitted with isolation valves.

- D. The "pig" launchers shall be of steel construction, suitable for 250 psi working pressure. The flange connection shall be flat face, matching ASME B16.1, 125 pound flanges.
- E. Pipe cleaning equipment shall be as manufactured by Montauk Services, Inc., or approved equal.
- F. A factory representative, who has complete knowledge of proper operation and maintenance shall be provided for one eight-hour day to instruct representatives of the Owner and Engineer on proper operation and maintenance, including startup and shutdown procedures, proper lubrication practices, if applicable, and troubleshooting of all equipment. If there are any difficulties with the training or in the operation of the equipment due to the manufacturer's design, fabrication or Contractor's installation, additional startup and training services shall be provided at no additional cost to the Owner.

2.20 SPRAY NOZZLES:

- A. Nozzles shall be of the size, with feed rates as noted on the Drawings. Nozzles shall be attached to the distribution header, as indicated on the Drawings, via split-eyelet connections. Unless otherwise noted nozzles shall be Type 316 stainless steel or brass.
- B. Each nozzle shall be furnished with a stainless-steel adjustable ball fitting.
- C. The distribution piping to the nozzles shall be sloped for drainage and shall be adequately supported under the access bridge to prevent sagging, while facilitating access for nozzle replacement. The Contractor shall test the system to demonstrate to the Engineer that it is entirely self-draining prior to acceptance.
- D. Two (2) nozzles per system shall be provided as spares and shall be suitably boxed and marked for storage.
- E. All nozzles shall be the appropriate model, as manufactured by Spraying Systems Incorporated or approved equal.

2.21 APPURTENANCES AND MISCELLANEOUS ITEMS:

- A. All gaskets, glands, bolts, nuts and other required hardware shall be provided for connection of piping and appurtenances. Bolts and nuts shall be high strength, Type 316 stainless steel if submerged, buried, or subject to splashing and cadmium plated otherwise, with tee-head and hexagon nut. All other hardware

shall be of the size, type and number as required and recommended by the piping or appurtenance manufacturer and as specified herein.

- B. All gaskets for flanges shall be full face and suitable for 200 degrees F operating temperature, unless higher temperature required on individual systems and the fluids carried. See also Division 1.
- C. Plugs, caps and similar accessories shall be of the same material as the pipe and of the locking type, unless otherwise noted.
- D. Unions shall be of the same material as the pipe, except for dielectric connections.
- E. Special protective tape shall be fabric reinforced petroleum tape as manufactured by Denso Inc., Houston, TX or approved equal.

2.22 COLOR CODING AND LABELING:

A. General

1. Provide a complete color-coding system consisting of preprinted labels and banding as manufactured by Brady; Seton or approved equal. Field painting shall be specified in Division 09.
2. Piping system identification shall comply with the requirements of ANSI A13.1.
3. Colors listed are general. Actual colors will be selected based on a comparison to the existing plant color codes, except as otherwise indicated; samples shall be furnished for all pipe paint colors; with chips from existing piping where new service lines are connecting.
4. Banding

Unless special spacing is listed in schedule, apply banding to pipe at connections to equipment, valves, branch fittings, at wall, floor, or ceiling boundaries and at intervals not greater than 36-ft.
5. Labels and Directional Arrows
 - a. Apply labels with directional arrows at connections to equipment, valves, branch fittings, at least one wall, floor, or ceiling boundary within a room and at intervals not greater than 36-ft.
 - b. At each label, arrows indicating direction of flow shall point away from label. If flow may be in both directions, use double headed arrows.

c. Lettering shall bear the full pipe system name as scheduled.

d. Lettering height shall be as follows:

Outside Pipe Diameter	Minimum Letter Height
¾-inch to 1¼-inch	½-inch
1½-inch to 2-inch	¾-inch
2½-inch to 6-inch	1¼-inch
8-inch to 10-inch	2½-inch
Over 10-inches	3½-inch

e. Two (2) labels minimum each room, crawl space or compartment, unless otherwise approved.

PART 3 - EXECUTION

3.01 GENERAL:

- A. All dirt, scale, weld splatter, water and other foreign matter shall be removed from the inside and outside of all pipe and sub-assemblies prior to installing.
- B. All pipe joints and connections to equipment shall be made in such a manner as to produce a minimum of strain at the joint.
- C. Install piping in a neat manner with lines straight and parallel or at right angles to walls or column lines and with risers plumb. Run piping so as to avoid passing through ductwork or directly under electric light outlets, and/or interference with other lines [or extending beyond furring lines as determined by Architectural Drawings]. All work shall be accomplished using recognized methods and procedures of pipe fabrication and in accordance with the latest revision of applicable ANSI Standards, ASME Codes and Pipe Fabrication Institute Standards.
 - 1. Use full length of pipe except where cut lengths are necessary. Do not spring or deform piping to make up joints.
 - 2. Pipe shall be cut square, not upset, undersize or out of round. Ends shall be carefully reamed and cleaned before being installed. Bending of pipe is not permitted. Use fittings for all changes in direction.

3. Do not use bushings except where specifically approved by the Engineer. Reducers shall be eccentric to provide for drainage from all liquid-bearing lines and facilitate air removal from water lines.
4. Verify the locations and elevations of any existing piping and manholes before proceeding with work on any system. Any discrepancies between the information shown on the Drawings and the actual conditions found in the field shall be reported at once to the Engineer. No claim for extra payment will be considered if the above provision has not been complied with.
5. Where lines of lower service rating tie into services or equipment of higher service rating the isolation valve between the two shall conform to the higher rating.
6. Mitering of pipe to form elbow is not permitted.
7. All piping interiors shall be thoroughly cleaned after installation and kept clean by approved temporary closures on all openings until the system is put in service. Open pipe ends shall be subjected to recleaning and retesting.
8. End caps on pre-cleaned pipe shall not be removed until immediately before assembly. All open ends shall be capped immediately after completion of installation.
9. Provide temporary strainers within the piping ahead of every piece of equipment. The strainers shall be cleaned and reinserted immediately before start-up. The strainers shall be kept in service until at least seven (7) days after the equipment has been put in service.

D. Test Connections

Provide ½-inch female N.P.T. test connection equipped with ½-inch brass plug on all pump suction and discharge lines. Where indicated on the Drawings, test connections should be equipped with bar stock valve and gage. Provide test connections at all steam traps. The connection shall be located on the discharge side of the trap between the trap and the first valve. It shall consist of a ½-inch branch connection terminated with a gate valve.

E. Installation of Expansion Joints and Flexible Connectors

1. Piping systems shall be aligned prior to installation of expansion fittings. Alignment shall be provided by fitting a rigid pipe spool in place of the expansion joint. Prior to testing of the piping system, the pipe spool shall be replaced with the specified expansion or flexible fitting.
2. In addition to the locations noted on the Drawings and in PART 2 of this Section, expansion fittings and anchors shall be located and spaced as specified by the Expansion Joint Manufacturer's Association. The expansion joints/flexible connectors shall not be installed during times of temperature extreme or in a fully compressed or fully expanded condition.

F. Installation of Sleeve Couplings

1. Unless otherwise required by the manufacturer's instructions, prior to installation of sleeve couplings, the pipe ends shall be cleaned thoroughly for a distance of at least 12-inches. Soapy water may be used as a gasket lubricant. A follower and gasket, in that order, shall be slipped over each pipe to a distance of about 6-inches from the end, the middle ring shall be placed on the already installed pipe and shall be inserted into the middle ring flair and brought to proper position in relation to the pipe already installed. The gaskets and followers shall then be pressed evenly and firmly into the middle ring flares.
2. After the bolts have been inserted and all nuts have been made up fingertight, diametrically opposite nuts shall be progressively and uniformly tightened all around the joint, preferably by use of a torque wrench of the appropriate size and torque for the bolts.
3. The correct torque as indicated by a torque wrench shall not exceed 75 ft-lb for $\frac{5}{8}$ -inch bolts and 90 ft-lb for $\frac{3}{4}$ -inch bolts.
4. If a wrench other than a torque wrench is used, it should be no longer than 12-inches so that when used by the average person the above torque values shall not be exceeded.
5. To prevent sleeve couplings from pulling apart under pressure, a suitable harnessing or flange clamp assembly shall be provided and installed where shown on the Drawings or directed by the Engineer concerning anchorage.
6. Note the additional locations required for sleeve couplings in PART 2 of this Specification. Also note Contractor's responsibility for locating, providing and installing restraints.

G. Installation of Split Couplings

1. Prior to assembly of split couplings, grooves, or shoulders of the pipe as well as other parts shall be thoroughly cleaned. The ends of the pipes and outside of the gaskets shall be moderately coated with petroleum jelly, cup grease, soft soap, or graphite paste and the gasket shall be slipped over one pipe end. After the other pipe has been brought to the correct position, the gasket shall be centered properly over the pipe ends with the lips against the pipes. The housing sections then shall be placed.
2. Insure that the joints are fully extended after the rings are in place and prior to tightening the bolts. After the bolts have been inserted, the nuts shall be tightened until the housing sections are firmly in contact, as required by the manufacturer, without excessive bolt tension or strain on the pipe.

H. Installation of Pipeline Appurtenances

1. All pipeline appurtenances shall be installed as required and in accordance with the manufacturer's recommendations, as acceptable to the Engineer.
2. Gages, meters and similar in-line items shall be isolated from testing pressures in excess of the rated pressure of the assembly.
3. Use Teflon tape on all screwed fittings.

I. Installation of Unions

1. Use unions to allow dismantling of pipe, valves, and equipment.

J. Welding

1. Welding shall be in accordance with ANSI Standard B31 and AWS B3.0.
2. Install welding fittings on all welded lines. Make changes in direction and intersection of lines with welding fittings. Do not miter pipes to form elbows or notch straight runs to form tees, or any similar construction. Do not employ welder who has not been fully qualified in above specified procedure and so certified by approved welding bureau or similar locally recognized testing authority.

K. Installation of Flanged Joints

1. Make flanged joints with bolts; bolt studs with nut on each end; or studs with nuts where one flange is tapped. Use number and size of bolts conforming to same ANSI Standard as flanges. Before flanges pieces are

assembled, remove rust resistant coating from machined surfaces, clean gaskets and smooth all burrs and other defects. Make up flanged joints tight, care being taken to prevent undue strain upon valves or other pieces of equipment.

3.02 TESTING:

- A. Test all pipelines for water/gas tightness as specified in the Piping or System sections. Furnish all labor, testing plugs or caps, pressure pumps, pipe connections, gages and all other equipment required. Testing shall be performed in accordance with one or more of the testing procedures appended to this Section as specified in each Piping or System Section. All testing shall be performed in the presence of the Engineer.
- B. Repair faulty joints or remove defective pipe and fittings and replace as approved by the Engineer. Retest.

3.03 DISINFECTION:

- A. After satisfactory testing, all plant water and protected water collection and distribution systems shall be thoroughly disinfected with a solution of not less than 50 parts per million of available chlorine. The disinfecting solution shall be allowed to remain in the system for a period of 24 hours during which time all valves shall be operated. The residual chlorine after 24 hours should not be less than 25 ppm.
- B. Water being flushed from structures or pipelines after disinfection with a chlorine residual of 2 mg/l or greater, shall be treated with a dechlorination solution, in a method approved by the Engineer, prior to discharge.
- C. Chlorine products for disinfecting water pipes are available in several forms as follows:
 - 1. Liquid Chlorine is available in 100 and 150 pound steel cylinders.
 - 2. High test calcium hypochlorite is a powder and is available in 4 lb. tins and 100 lb. drums. The chlorine content is approximately sixty-five percent (65%) to seventy percent (70%) (equivalent to commercial products know as “perchloron”, H.T.H., Maxochlor,” etc.).

Town personnel will be responsible for the collection of water samples from new water lines or systems. Service laterals to residences or other buildings shall not be connected to new water mains until the Town’s tests have indicated that these mains are safe from contamination. Application of chemicals into the line as it is laid is prohibited.

A minimum of 48 hours prior to chlorination, the Contractor shall notify the Town so that they may schedule the collection of the required sample(s).

END OF SECTION

SECTION 400507

PIPE HANGERS AND SUPPORTS

PART 1 - GENERAL

1.01 SCOPE OF WORK:

- A. Furnish all labor, materials, equipment, and incidentals and install a complete system of pipe hangers, supports, concrete inserts and anchor bolts including all metallic hanging and supporting devices for supporting non-buried piping as shown on the Drawings and as specified herein.
- B. The absence of pipe supports and details on the Drawings shall not relieve the Contractor of the responsibility for providing them. Pipe supports indicated on the Drawings are shown only to convey the intent of the design for a particular location and are not intended to represent a complete system.

1.02 RELATED WORK:

- A. Concrete is included in Division 030000.
- B. Field painting is included in Division 090000.
- C. Pipe and fittings are included in respective sections of Division 400000.
- D. Valves and appurtenances are included in Division 400000.

1.03 SUBMITTALS:

- A. Submit to the Engineer as provided in Section 400510, complete sets of shop drawings of all items to be furnished under this Section. Submittals shall include complete layouts, schedules, location plans and complete total bill of materials for all pipe support systems. All pipe supports shall be stamped/sealed by an engineer licensed in the state of Tennessee.
- B. Submittals shall include a representative catalog cut for each different type of pipe hanger or support indicating the materials of construction, important dimensions and range of pipe sizes for which that hanger is suitable. Where standard hangers and/or supports are not suitable, submit detailed drawings showing materials and details of construction for each type of special hanger and/or support.
- C. Submittals shall include complete piping drawings as submitted for each piping submittal indicating type of hanger and/or support, location, magnitude of load

transmitted to the structure and type of anchor, guide and other pipe supporting appurtenances. Submittals shall use detail numbers as shown on the Drawings to indicate type of support proposed whenever possible.

- D. Types and locations of pipe hangers and/or supports shall also be shown on the piping layouts for each piping submittal as specified in the respective Division 400500, pipe specifications.
- E. Submit complete design data for pipe support systems to show conformance with this Specification.

1.04 REFERENCE STANDARDS:

- A. Manufacturer's Standardization Society (MSS):
 - 1. MSS SP-58 Pipe Hangers and Supports - Materials and Design.
 - 2. MSS SP-69 Pipe Hangers and Supports - Selection and Application.
- B. American Society for Testing and Materials (ASTM):
 - 1. ASTM A36 Structural Steel.
 - 2. ASTM A307 Carbon Steel Externally and Internally Threaded Standard Fasteners.
- C. American National Standards Institute (ANSI):
 - 1. ANSI B31 Power Piping.
- D. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 QUALIFICATIONS:

- A. All hangers, supports and appurtenances shall conform to the latest applicable requirements of ANSI B31.1, except as supplemented or modified by the requirements of this Specification.
- B. All hangers, supports and appurtenances shall be of approved standard design where possible and shall be adequate to maintain the supported load in proper position under all operating conditions. The minimum working factor of safety for all supporting equipment, with the exception of springs, shall be five times the ultimate tensile strength of the material, assuming 10-feet of waterfilled pipe being supported.

- C. All pipe and appurtenances connected to equipment shall be supported in such a manner as to prevent any strain being imposed on the equipment. When manufacturers have indicated requirements that piping loads shall not be transmitted to their equipment, submit certification stating that such requirements have been complied with.

1.06 DELIVERY AND STORAGE:

- A. All supports and hangers shall be crated, delivered and uncrated so as to protect against any damage.
- B. All parts shall be properly protected so that no damage or deterioration shall occur during a prolonged delay from the time of shipment until installation is completed.
- C. Finished metal surfaces not galvanized, that are not of stainless steel construction, or that are not coated, shall be grease coated, to prevent rust and corrosion.

PART 2 - PRODUCTS

2.01 GENERAL:

- A. All of the equipment specified herein is intended to support the various types of pipe and piping systems. The details shown on the Drawings are intended to indicate the generally desired methods of support under normal conditions. It shall be the responsibility of the Contractor to develop final details and any details associated with special conditions not already covered to meet the system conditions specified in the respective Division 400000 pipe specifications.
- B. All pipe and tubing shall be supported as required to prevent significant stresses in the pipe or tubing material, valves, fittings and other pipe appurtenances and to support and secure the pipe in the intended position and alignment. All supports shall be designed to adequately secure the pipe against excessive dislocation due to thermal expansion and contraction, internal flow forces, and all probable external forces such as equipment, pipe, and personnel contact. Any structural steel members required to brace any piping from excessive dislocation shall conform to the applicable requirements of Division 400000 and shall be furnished and installed under these Sections.
- C. Hangers and supports shall be spaced in accordance with ANSI B31.1 except that the maximum unsupported span shall not exceed 10 feet unless otherwise specified herein.
- D. Where flexible couplings are required at equipment, tanks, etc. the end opposite to the piece of equipment, tank, etc. shall be rigidly supported.

- E. All pipe and appurtenances connected to the equipment shall be supported in a manner to prevent any strain from being imposed on the equipment or piping system.
- F. All rods, clamps, hangers, inserts, anchor bolts, brackets, and components for interior pipe supports shall be furnished with galvanized finish, hot dipped or electro-galvanized coated, except where field welding is required. Interior clamps on plastic pipe shall be plastic coated. Supports for copper pipe shall be copper plated or shall have a 1/16-in plastic coating. All rods, clamps, hangers, inserts, anchor bolts, brackets, and components for submerged pipe, exterior pipe and pipe within outdoor structures shall be of Type 316 stainless steel.
- G. All non-insulated non-metallic piping such as PVC, CPVC, etc. shall be protected from local stress concentrations at each support point. Support material shall be as defined in Part 2.1(F) of this Section. Where pipes are bottom supported 180 degrees, arc shields shall be furnished. Where 360 degree arc support is required, such as U bolts, protection shields shall be provided for the entire pipe circumference. Arc support material shall be as defined in Part 2.1(F) of this Section. Protection shields shall have an 18 gauge minimum thickness, not be less than 12-inches in length and be securely fastened to pipe with stainless steel or galvanized metal straps not less than ½-inch wide.
- H. All insulated pipe shall be furnished with a rigid foam insulating saddle at each pipe support location as specified under respective pipe insulation. Provide protection shields as specified in Part 2.1(G) at each support location.
- I. Supports shall be sufficiently close together such that the sag of the pipe is within limits that will permit drainage and avoid excessive bending stresses from concentrated loads between supports.
- J. Where pipe hangers and supports come in contact with copper piping provide protection from galvanic corrosion or use copper plated or PVC coated hangers and supports.
- K. Pipe supports shall be provided as follows:
 - 1. Ductile iron piping shall be supported at a maximum support spacing of 10 feet with a minimum of one support per pipe section at the joints.
 - 2. Steel and stainless steel piping 2½ inch or larger diameter shall be supported at a maximum support spacing of 10 feet with a minimum of one support per pipe section at the joints.
 - 3. Support spacing for steel and stainless steel piping 2 inch and smaller diameter and copper tubing shall not exceed 5 feet.

4. PVC pipes shall be supported as recommended by the manufacturer except that in no case shall support-spacing exceed 5 feet.
 5. All vertical pipes shall be supported at each floor or at intervals of not more than 12 feet by approved pipe collars, clamps, brackets, or wall rests and at all points necessary to insure rigid construction.
 6. Pipe supports shall not induce point loadings but shall distribute pipe loads evenly along the pipe circumference.
 7. Supports shall be provided at changes in direction and elsewhere as shown in the Drawings or as specified herein. No piping shall be supported from other piping or from metal stairs, ladders, and walkways, unless specifically directed or authorized by the Engineer.
 8. Pipe supports shall be provided to minimize lateral forces through valves, both sides of split type couplings, and sleeve type couplings and to minimize all pipe forces on equipment housings. Equipment housings shall not be utilized to support connecting pipes.
 9. Effects of thermal expansion and contraction of the pipe shall be accounted for in the pipe support selection and installation.
- L. Unless otherwise specified herein, pipe hangers and supports shall be as manufactured by Grinnell Co., Inc., Providence, RI; Carpenter & Patterson, Inc., Woburn, MA; Unistrut Corp., Klayne, MI; Chalfant Mfg. Co., Cleveland, OH; Metals Products Div.; U.S. Gypsum, Chicago, IL, or approved equal. Any reference to a specific figure number of a specific manufacturer is for the purpose of establishing a type and quality of product and shall not be considered as proprietary. Any item comparable in type, style, quality, design and performance shall be considered as equal.
- M. Any required pipe supports for which the supports specified in this Section are not applicable shall be fabricated or constructed from standard structural steel shapes, concrete and anchor hardware similar to items previously specified herein and shall be subject to the approval of the Engineer.
- N. Expansion anchors shall be equal to Kwik-Bolt as manufactured by the McCulloch Industries, Minneapolis, MI or Wej-it manufactured by Wej-it Expansion Products, Inc., Bloomfield, CO. The length of expansion bolts shall be sufficient to place the wedge portion of the bolt a minimum of 1 inch behind the steel reinforcement.
- O. Hanger rods shall be hot rolled steel, machine threaded and galvanized after fabrication for interior applications and stainless steel for all exterior applications.

The strength of the rod shall be based on its root diameter. Hanger rods shall be attached to concrete structures using concrete inserts similar to F&S Figures 180, 571 or 150; or continuous concrete inserts per F&S. Inserts shall be malleable iron, or steel with galvanized finish or stainless steel. Beam clamps, C clamps or welded beam attachments shall be used for attaching hanger rods to structural steel members. Where necessary and approved by the Engineer, expansion anchors shall be used for attaching to concrete structures.

- P. All uninsulated non-metallic piping such as PVC, CPVC, etc shall be protected from local stress concentrations at each support point. Protection shall be provided by galvanized steel protection shields or other method as approved by the Engineer for interior applications and stainless steel shields for exterior applications. Where pipes are bottom supported 180 degrees, arc shields shall be furnished. Where 360 degree arc support is required, such as U bolts, protection shields shall be provided for the entire pipe circumference. Protection shields shall have an 18 gauge minimum thickness, not be less than 12-inch in length and be securely fastened to pipe with stainless steel or galvanized metal straps not less than ½-inch wide.

2.02 SINGLE PIPE HANGERS:

- A. Single pipes shall be supported by hangers suspended by galvanized steel rods from structural steel members, concrete ceilings, beams, and wall mounted steel angle brackets.
- B. Hanger rods shall be hot rolled steel, machine threaded and galvanized after fabrication. The strength of the rod shall be based on its root diameter.
- C. Except as otherwise specified herein, pipe hangers shall be steel, of the adjustable clevis type similar to Grinnell Figure Numbers 65, 260, and 590 as required. Hangers shall be carbon steel with a galvanized finish.
- D. Hangers for individual PVC pipes shall be Grinnel Figure 97C rated hangers.
- E. Hanger rods shall be attached to concrete structures using individual concrete inserts similar to Grinnel Figure No. 282 or continuous inserts similar to Carpenter and Patterson Figure 1480. Inserts shall be malleable iron, C clamps or welded beam attachments shall be used for attaching hanger rods to structural steel members. Where necessary and approved by the Engineer, double expansion shields shall be used for attaching to concrete structures.

2.03 MULTIPLE PIPE HANGERS:

- A. Suspended multiple pipes, running parallel in the same horizontal plane, which are adjacent to each other shall be suspended by trapeze type hangers or wall brackets. Trapeze hangers shall consist of galvanized structural steel channel

supported from galvanized threaded rod or attached to concrete walls, columns or structural steel support members as required to meet the intent of this specification. Channel shall be similar to Carpenter and Patterson Figure 371. Rods, concrete inserts, "C" Clamps, beam clamps, and welded beam attachments shall be as specified in Paragraph 2.02 Single Pipe Hangers above.

- B. Except as otherwise specified herein pipe anchors used for attaching pipe to trapeze or multiple pipe wall brackets shall be anchor or pipe chairs similar to Carpenter and Patterson Figure 127. Material of construction shall be galvanized steel. Chair "U" bolts shall be tightened to allow freedom of movement for normal expansion and contraction except where pipe must be anchored to control direction of movement or act as a thrust anchor.
- C. Non-submerged multiple PVC pipes shall be supported by supports fabricated from 1 $\frac{5}{8}$ -inch steel metal framing equal to Unistrut Figure P1000. Channels, supports, wall brackets and other accessories shall be sized and constructed in accordance with the manufacturer's recommendations. Channels and parts shall be furnished with rust inhibiting acrylic enamel paint. Pipe clamps, nuts, bolts and washers shall be stainless steel.
- D. Submerged PVC piping (either individual pipes or multiple piping) shall be supported by Type 316 stainless steel, 1 $\frac{5}{8}$ -inch channel framing and secured with non-metallic or 316 stainless steel pipe clamps. Accessory parts shall be Type 316 stainless steel.

2.04 SINGLE AND MULTIPLE PIPE SUPPORTS:

- A. Single pipes located in a horizontal plane close to the floor shall be supported by one of the methods specified herein or as shown on the Drawings.
- B. Pipes 3 inches in diameter and larger shall be supported by adjustable stanchions similar to Carpenter and Patterson Figure 101, constructed of galvanized steel for interior applications and stainless steel for exterior applications. Stanchions shall provide at least 4-inches adjustment and be flange mounted to floor.
- C. Pipes less than 3 inches in diameter shall be held in position by supports fabricated from steel metal framing equal to Unistrut Figure P1000, welded post base similar to Unistrut Figure P2072A and pipe clamps similar to Unistrut Figures P1109SS thru P1119SS. Where required to assure adequate support, fabricate supports using two (2) vertical members and post bases connected together by horizontal member of sufficient load capacity to support pipe. Wherever possible supports shall be fastened to nearby walls or other structural member to provide horizontal rigidity. More than one pipe may be supported from a common fabricated support. All supports unless specified elsewhere shall be furnished with rust inhibiting acrylic enamel paint.

- D. Where shown on the Drawings, pipe shall be supported using concrete piers, cradles or posts. Pipe shall be securely fastened to the concrete using suitable metal straps as required and as approved by the Engineer.

2.05 WALL SUPPORTED PIPES:

- A. Single or multiple pipes located adjacent to walls, columns or other structural members, whenever deemed necessary, shall be supported using welded steel wall brackets similar to Carpenter and Patterson Figure numbers 69-78, 84, or 139; or metal framing type steel brackets and pipe clamps. All members shall be securely fastened to wall, column, etc. using double expansion shields or other method as approved by the Engineer. Additional wall bearing plates shall be provided where required.
- B. Pipe shall be attached to supports using methods hereinbefore specified to meet the intent of this Specification.
- C. All supports shall be galvanized, except that metal framing shall be furnished with enamel finish.

2.06 BASE ANCHOR SUPPORT:

- A. Where pipes change direction from horizontal to vertical via a bend, a welded or cast base anchor support shall be installed at the bend to carry the load. The bend anchor shall be fastened to the floor, with double expansion shields or other method as approved by the Engineer.
- B. Where shown on the Drawings, pipe bends shall be supported using concrete anchor posts. Pipes shall be securely fastened to the concrete supports with suitable metal bands as required and approved by the Engineer.

2.07 VERTICAL PIPE SUPPORTS:

- A. Where vertical pipes are not supported by a Unistrut system, they shall be supported in one of the following methods.
 - 1. For pipes ¼-inches to 2-inches in diameter, an extension hanger ring shall be provided with an extension rod and hanger flange. The rod diameter shall be as recommended by the manufacturer for the type of pipe to be supported. The hanger ring shall be galvanized steel or PVC clad depending on the supported pipe. The hanger ring shall be equal to Carpenter & Paterson Fig. No. 81 or 81CT. The anchor flange shall be galvanized malleable iron similar to Carpenter and Patterson Figure No. 85.

2. For pipes equal to or greater than ½-inches in diameter offset pipe clamps similar to Carpenter and Patterson Figure No. 179 may be used. The hanger shall be attached to concrete structures using double expansion shields.
3. Pipe riser clamps shall be used to support all vertical pipes extending through floor slabs. Riser clamps shall be galvanized steel similar to Carpenter and Patterson Figure No. 126. Copper clad, Carpenter and Patterson Figure 126CT or PVC coated clamps shall be used on copper pipes. Insulation shall be removed from insulated pipes prior to installing riser clamps.
4. Unless otherwise specified, shown, or specifically approved by the Engineer, vertical runs exceeding 12 feet shall be supported by approved pipe collars, clamps, brackets or wall vests at all points required to ensure a rigid installation.

2.08 TRAY SUPPORT:

- A. Hose and PVC piping may be supported continuously by ladder type aluminum tray. Trays shall be 12-inch minimum width by 4-inch nominal depth with 6-inch rung spacing. Trays shall have aluminum drip shield to prevent leakage onto flooring. Trays shall be sloped towards drains where risers shall pipe any chemical leakage to drain. Trays shall be furnished complete with aluminum fittings, plates, wall brackets, hangers, clips, rods, etc. for a complete system and to ensure that the trays are rigidly supported in accordance with the manufacturer's recommendations. Fitting shall have a 3 foot minimum turning radius. Pipe shall be secured to the rungs with plastic ties. Trays shall be as manufactured by Chalfant, Husky-Burndy of Metal Products Division of United States Gypsum or approved equal.

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. All pipes, horizontal and vertical, requiring rigid support shall be supported from the building structure by approved methods. Supports shall be provided at changes in direction and elsewhere as shown in the Drawings or specified herein. No piping shall be supported from metal stairs, ladders and walkways unless specifically directed or authorized by the Engineer.
- B. All pipe supports shall be designed with liberal strength and stiffness to support the respective pipes under the maximum combination of peak loading conditions to include pipe weight, liquid weight, liquid movement and pressure forces,

thermal expansion and contraction, vibrations and all probable externally applied forces. Prior to installation, all pipe supports shall be approved by the Engineer.

- C. Pipe supports shall be provided to minimize lateral forces through valves, both sides of split type couplings and sleeve type couplings, and to minimize all pipe forces on pump housings. Pump housings shall not be utilized to support connecting pipes.
- D. Inserts for pipe hangers and supports shall be installed on forms before concrete is placed. Before setting these items, all Drawings and figures shall be checked which have a direct bearing on the pipe location. Responsibility for the proper location of pipe supports is included under this Section.
- E. Continuous metal inserts shall be embedded flush with the concrete surface.
- F. Hose and pipe shall be installed neatly in trays. Minimum turning radius shall be three feet. Pipe and hose shall lay flat on bottom of tray and shall be secured in place.

3.02 TESTING:

- A. All pipe support systems shall be tested for compliance with the Specifications. After installation, each pipe support system shall be tested in conjunction with the respective piping pressure tests. If any part of the pipe support system proves to be defective or inadequate, it shall be repaired or augmented under this Section to the satisfaction of the Engineer.

END OF SECTION

SECTION 400509

PIPE PENETRATIONS

PART 1 - GENERAL

1.01 SCOPE OF WORK:

Furnish all labor, materials, equipment, and incidentals required and install pipe penetration assemblies as shown. This Section covers materials for the various pipe penetration configurations.

1.02 SUBMITTALS:

Submit manufacturers' literature, installation instructions, and where applicable, fire rating and certified test results of the various components on all items to be furnished in accordance with Divisions 400500.

PART 2 - PRODUCTS

2.01 PIPE SLEEVES:

Unless otherwise shown all pipe sleeves shall be Schedule 40 galvanized steel pipe conforming to ASTM A53. Where indicated, provide a 2-in minimum circumferential water stop welded to exterior of sleeve at its midpoint. The ends of sleeves shall be cut and ground smooth and shall be flush with the wall or ceiling and extend 2-in above finished floors. Sleeves to be sealed with mechanical seals shall be sized in accordance with the seal manufacturer's recommendations. Sleeves to be sealed by caulking and sleeves for insulated piping shall be sized as required.

2.02 WALL CASTINGS (WALL SLEEVES OR WALL PIPES):

Unless otherwise shown, wall castings shall be ductile iron conforming to ANSI/AWWA A21.51/C151, thickness Class 53, diameter as required. Flanges and/or mechanical joint bells shall be drilled and tapped for studs where flush with the wall. Castings shall be provided with a 2-in minimum circumferential flange/waterstop integrally cast with or welded to the casting, located as follows: for castings set flush with walls located at the center of the overall length of the casting; for castings which extend through wall located within the middle third of the wall. All wall castings shall be provided with stainless steel hardware.

2.03 SEALING MATERIALS:

- A. Mechanical seals shall be modular, adjustable, bolted, mechanical type consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and sleeve. The seal shall be rated by the manufacturer for 40-ft of head or 20 psig and shall be fire rated. All mechanical seals shall be provided with stainless steel hardware. Mechanical seals shall be Link-Seal by Thunderline Corp., Wayne, MI or approved equal.
- B. Sealant shall be a two part foamed silicone elastomer by Dow Corning Co., Product No. 3-6548 silicone R.T.V.; 3M brand fire barrier products caulk C.P. 25 and 3M brand putty 303; or Flame-Safe fire stop systems Fig. No. FS-500 by Thomas & Betts Corp or approved equal. Sealant bead configuration, depth and width shall be in accordance with manufacturer's recommendations.

2.04 MISCELLANEOUS MATERIALS:

- A. Bonding compound shall be Sikadur Hi-Mod epoxy by Sika Corp.; Euclid Chemical Corp.; Master Builders Company or approved equal.
- B. Non-shrink grout shall be Masterflow 713 by Master Builders Co.; Euco N-S by Euclid Chemical Co.; Five Star Grout by U.S. Grout Corp. or approved equal.

PART 3 - EXECUTION

3.01 INSTALLATION:

Assemble and install components of pipe penetration assemblies as detailed on the Drawings and per manufactures instructions.

END OF SECTION

SECTION 400510

PIPING – GENERAL REQUIREMENTS

PART 1 - GENERAL

1.01 SCOPE:

This Section specifies the basic administrative and testing requirements for piping. Specific piping materials, systems and related installation and testing requirements are specified in other Sections of Division 400500.

1.02 RELATED WORK:

- A. Piping materials and systems are included in other Sections of Division 400500.
- B. Valves are included in Section 400562.
- C. Pipe Testing - General Requirements are included in Section 400506.

1.03 SUBMITTALS:

- A. General submittals for piping and piping systems are listed below. Submittals shall be in accordance with Sections 400510 and 400520. It is not intended that all submittals listed below be provided for all piping materials and systems. Refer to individual System or Piping Sections for specific submittals.
- B. Shop Drawings and Product Data
 - 1. Piping layouts in full detail.
 - 2. Location of pipe hangers and supports.
 - 3. Location and type of backup block or device to prevent joint separation.
 - 4. Large scale details of wall penetrations and fabricated fittings.
 - 5. Schedules of all pipe, fittings, special castings, couplings, expansion joints and other appurtenances.
 - 6. Catalog cuts of joints, couplings, harnesses, expansion joints, gaskets, fasteners and other accessories.
 - 7. Brochures and technical data on coatings and linings and proposed method for application and repair.
- C. Samples
- D. Design Data

- E. Test Reports
 - 1. Six copies of certified shop tests showing compliance with appropriate standard.
 - 2. Six copies of all field test reports, signed by Contractor and Engineer.
- F. Certificates
 - 1. Copies of certification for all welders performing work in accordance with ANSI B31.1.
- G. Manufacturers Installation (or application) instructions.
- H. Statement of Qualifications
- I. Manufacturers Field Report
- J. Project Record Document
- K. Operation and Maintenance Data in accordance with Section 01600.
- L. Warranties

1.04 REFERENCE STANDARDS:

- A. American Society for Testing and Materials (ASTM)
 - 1. ASTM A307 - Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength
- B. American National Standards Institute (ANSI)
 - 1. ANSI B16.5 - Pipe Flanges and Flanged Fittings
 - 2. ANSI B31.1 - Power Piping
- C. American Welding Society (AWS)
 - 1. AWS B3.0 - Welding Procedure and Performance Qualifications
- D. American Water Works Association (AWWA)
 - 1. AWWA Manual M11 - Steel Pipe - A Guide for Design and Installation
- E. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 QUALITY ASSURANCE:

- A. All materials shall be new and unused.
- B. Install piping to meet requirements of local codes.
- C. Provide manufacturer's certification that materials meet or exceed minimum requirements as specified. Reference to standards such as ASTM and ANSI shall apply to those versions in effect at the time of bid opening.
- D. Coordinate dimensions and drilling of flanges with flanges for valves, pumps and other equipment to be installed in piping systems. Bolt holes in flanges to straddle vertical centerline.
- E. Reject materials contaminated with gasoline, lubricating oil, liquid or gaseous fuel, aromatic compounds, paint solvent, paint thinner and acid solder.
- F. Pipe-joint compound, for pipe carrying flammable or toxic gas, must bear approval of Underwriters' Laboratories or Factory Mutual Engineering Division.
- G. Unless otherwise specified, pressures referred to in all Piping Sections are expressed in pounds per square inch gage above atmospheric pressure, PSIG, and all temperatures are expressed in degrees Fahrenheit.

1.06 DELIVERY, STORAGE AND HANDLING:

During loading, transportation and unloading, take care to prevent damage to pipes and coating. Carefully load and unload each pipe under control at all times. Place skids or blocks under each pipe in the shop and securely wedge pipe during transportation to ensure no injury to pipe and lining.

PART 2 - PRODUCTS

2.01 MATERIALS:

- A. Specific piping materials and appurtenances are specified in the respective Piping or System Sections.
- B. General installation materials shall be as specified below.
 - 1. Unions shall be brass or bronze unions for joining nonferrous pipe; malleable brass or bronze-seated iron or steel unions for joining ferrous pipe; PVC unions for joining PVC pipe; CPVC unions for joining CPVC pipe.

2. Flanged Joints. Bolt and nuts, Grade B, ASTM A307, hot dip galvanized, bolt number and size same as flange standard; studs - same quality as machine bolts; 1/16-in thick rubber gaskets with cloth insertions; rust-resistant coatings.
3. Temporary Plugs shall be standard plugs or caps which are suitable for permanent service.
4. Flexible Connections shall be flanged spool type, 180 degree F maximum service, single filled arch with synthetic rubber tube and cover, steel-ring reinforced synthetic fiber carcass, with flanges drilled to 150-lb ANSI B16.5 Standard. Stainless steel retaining rings, control rods and compression sleeves shall be provided where shown and as required for the working pressure of the system in which the joint is installed. All flexible joints shall be rated for the working pressure of the system in which they are installed. Flexible connections shall be Red Valve or equal.

2.02 INSULATION:

- A. Piping, valves and appurtenances shall be insulated as shown on the Drawings and specified herein. In general, all liquid lines subject to freezing shall be insulated. Gravity drain lines that are normally empty shall not be insulated. In addition, all lines to be insulated shall be heat traced with self-regulating electrical heat as specified in Division 16.
- B. Insulation products shall be manufactured by Owens-Corning, Johns-Manville or approved equal. The average thermal conductivity rating shall not exceed 0.25 Btu/hr-sq. ft.-°F per inch at a mean temperature of 75°F. Insulation shall have a flame spread rating not exceeding 25 and a smoke developed rating not higher than 50.
- C. All insulation exposed to the weather shall be furnished with an outer aluminum waterproof jacket and neatly secured in place with aluminum bands.
- D. Insulation shall be furnished for all piping, valves, and appurtenances on the line to be insulated. Insulation for valves and fittings shall be the same thickness as the connected pipe. No insulation shall interfere with the travel or working part of any valve stem or appurtenance.
- E. All outdoor chemical carrying piping, valves and appurtenances shall be freeze protected with heavy duty fiberglass insulation, Owens-Corning ASJ/SSL-II or approved equal. Insulation thicknesses shall be 1-1/2 inches for pipe sizes 1-1/2 inches and greater and 3/4-inch for pipes less than 1-1/2 inches.

PART 3 - EXECUTION

3.01 GENERAL:

- A. All dirt, scale, weld splatter, water and other foreign matter shall be removed from the inside and outside of all pipe and sub-assemblies prior to installing.
- B. All pipe joints and connections to equipment shall be made in such a manner as to produce a minimum of strain at the joint.
- C. Install piping in a neat manner with lines straight and parallel or at right angles to walls or column lines and with risers plumb. Run piping so as to avoid passing through ductwork or directly under electric light outlets and/or interference with other lines. All work shall be accomplished using recognized methods and procedures of pipe fabrication and in accordance with the latest revision of applicable ANSI Standards, ASME Codes and Pipe Fabrication Institute Standards.
 - 1. Use full length of pipe except where cut lengths are necessary. Do not spring or deform piping to make up joints.
 - 2. Pipe shall be cut square, not upset, undersize or out of round. Ends shall be carefully reamed and cleaned before being installed. Bending of pipe is not permitted. Use fittings for all changes in direction.
 - 3. Do not use bushings except where specifically approved by the Engineer. Reducers shall be eccentric to provide for drainage from all liquid-bearing lines and facilitate air removal from water lines.
 - 4. Verify the locations and elevations of any existing piping and manholes before proceeding with work on any system. Any discrepancies between the information shown on the Drawings and the actual conditions found in the field shall be reported at once to the Engineer. No claim for extra payment will be considered if the above provision has not been complied with.
 - 5. Where lines of lower service rating tie into services or equipment of higher service rating the isolation valve between the two shall conform to the higher rating.
 - 6. Mitering of pipe to form elbow is not permitted.
 - 7. All piping interiors shall be thoroughly cleaned after installation and kept clean by approved temporary closures on all openings until the system is put in service. Closures should be suitable to withstand the hydrostatic test.
 - 8. End caps on pre-cleaned pipe shall not be removed until immediately before assembly. All open ends shall be capped immediately after completion of installation.

D. Test Connections

1. Provide 1/2-in female N.P.T. test connection equipped with 1/2-in brass plug on all pump suction and discharge lines. Where indicated on the Drawings, test connections should be equipped with bar stock valve and gage.

E. Unions

1. Unions screwed or flanged shall be provided where indicated and in the following locations even if not indicated.
 - a. In long runs of piping to permit convenient disassembly for alterations or repairs.
 - b. In by-passes around equipment.
 - c. In connections to tanks, pumps and other equipment between the shut-off valve and the equipment.
 - d. In connections on both sides of traps, controls and automatic control valves.

F. Vents and Drains

1. Provide vents and drains in the following places:
 - a. Water Lines - Vents at high points and drains at low points.
 - b. Air Lines - Drains at low points.

3.02 WELDING:

- A. Welding in accordance with ANSI Standard B31 and AWS B3.0.
- B. Install welding fittings on all welded lines. Make changes in direction and intersection of lines with welding fittings. Do not miter pipes to form elbows or notching of straight runs to form tees, or any similar construction. Do not employ welder who has not been fully qualified in above specified procedure and so certified by approved welding bureau or similar locally recognized testing authority.

3.03 FLANGED JOINTS:

Make flanged joints with bolts; bolt studs with nut on each end; or studs with nuts where one flange is tapped. Use number and size of bolts conforming to same ANSI Standard as flanges. Before flanged pieces are assembled, remove rust resistant coating from machined surfaces, clean gaskets and smooth all burrs and other defects. Make up flanged joints tight, care being taken to prevent undue strain upon valves or other pieces of equipment.

3.04 SLEEVE COUPLINGS:

Install tie rods, pipe clamps or bridles when sleeve type couplings or fittings are used in piping system where indicated, and at changes in direction or other places as necessary, to prevent joints from pulling apart under pressure. Use bridles and tie rods at least 3/4-in in diameter, except where tie rods replace flange bolts of smaller size, in which case fit with nut on each side of pair of flanges. Joint harnessing shall conform, as a minimum, to the requirements for the bolts and tie bolt lugs as set forth in AWWA Manual M11.

3.05 WALL SLEEVE SEALS:

Use expandable rubber segmented sealing device as specified in Section 15053 with stainless steel fasteners to make watertight the annular space between pipe and sleeve. Determine the required inside diameter of each individual wall opening or sleeve to fit the pipe and seal to assure a watertight joint as recommended by the manufacturer, before ordering, fabricating or installing. Install pipe concentrically through wall sleeve. Install and tighten seal per manufacturer's instructions.

3.06 TESTING:

- A. Test all pipelines for water/gas tightness as specified in this Section, Section 15052, and other sections of Division 15. Furnish all labor, testing plugs or caps, pressure pumps, pipe connections, gages, and all other equipment required. Testing shall be performed in accordance with one or more of the testing procedures appended to this Section as specified in each Piping or System Section. All testing shall be performed in the presence of the Engineer or Engineer's Representative.
- B. Repair faulty joints or remove defective pipe and fittings and replace as approved by the Engineer. Retest.

3.07 INSTALLATION OF PIPING INSULATION:

- A. Omit the specified insulation at pipe supports and substitute rigid insulation such as cellular glass, calcium silicate, or expanded silica with a protective metal shield of a thickness and length as specified in MSS bulletin SP-69 Table 4. Secure the shield with at least three 1/2-in aluminum bands. Where piping is supported by roller hangers insulation saddles shall be installed.
- B. Vapor seal adhesive shall be used to seal seams and to butt sections on all cold piping if self sealing laps are not provided. The use of staples or any other fastening method that would penetrate the vapor barrier will not be permitted on cold piping systems. Staples may be used on hot piping systems where there is no potential for condensation.

- C. Where piping is provided with electric heat tracing the insulation shall not be installed until the heat tracing has been tested and accepted. Insulation shall be sized to allow for the heat tracing line without deforming the insulation.
- D. On vertical risers exceeding 15-ft in height, provide intermediate support for the insulation. For carbon steel pipe, this support shall consist of angle clips or other suitable devices welded to the pipe at about 15-ft on centers and concealed by the pipe covering. On non-carbon steel piping, clamps or other non-welded devices shall be used.
- E. Unless otherwise specified insulate all valves, control valves, fittings, pipe specialties and all other components that could be construed as being part of the piping system. Insulate valve bonnets to a point just below the stuffing box.
- F. Bridge flanges, unions, and pipe line strainers with block or sectional insulation wired in place. Wire shall be black steel, annealed. Stop the pipe insulation a sufficient distance to allow removal of flange bolts without disturbing the pipe insulation and extend the block, at least 2-in over the adjacent pipe insulation. Fill voids with blanket insulation.

END OF SECTION

SECTION 400519

DUCTILE IRON PIPE AND FITTINGS

PART 1 - GENERAL

1.01 SCOPE OF WORK:

- A. Furnish all labor, materials, equipment and incidentals required, install, and test ductile iron pipe and fittings for plant mechanical piping as shown on the Drawings and as specified herein.
- B. Mechanical piping shall include all piping and fittings installed above grade, in utility tunnel or gallery and shall exclude pipe in valve vaults, manholes, cleanouts and similar yard structures.
- C. Mechanical piping shall be installed as shown on the Drawings. Provide pipe supports, hangers and couplings as required to achieve a complete pipe system.
- D. Where the word "pipe" is used, it shall refer to pipe, fittings, or appurtenances unless otherwise noted.

1.02 RELATED WORK:

- A. General Piping Requirements are included in Section 400510.
- B. Valves and Appurtenances are included in Section 400562.
- C. Hydrostatic Testing is included in Section 400520.

1.03 DESCRIPTION OF SYSTEMS:

- A. Piping shall be installed in those locations as shown on the Drawings.
- B. The equipment and materials specified herein are intended to be standard types of ductile-iron pipe and ductile-iron fittings for use in transporting wastewater and water.

1.04 SUBMITTALS:

- A. Shop drawings and product data shall be submitted in accordance with Sections 01002 for Engineer's review. Shop drawings shall include piping layouts and schedules, dimensioning, fittings, locations of valves and appurtenances, joint details, methods and locations of supports and all other pertinent technical specifications for all piping to be furnished.
- B. Shop drawing submittals for piping under this Section shall include all data and information required for the complete piping systems. All dimensions shall be based on the actual equipment to be furnished. Types and locations of pipe hangers and/or supports shall be shown on the piping layouts for each piping submittal.

- C. Prior to shipment of pipe, submit a certified affidavit of compliance from the pipe manufacturer stating that the pipe, fittings, gaskets, linings and exterior coatings for this project have been manufactured and tested in accordance ANSI/AWWA and ASTM standards and requirements specified herein.

1.05 REFERENCE STANDARDS:

- A. American Society for Testing and Materials (ASTM)
 - 1. ASTM A377 - Standard Index for Specification for Ductile-Iron Pressure Pipe
 - 2. ASTM C150 - Standard Specification for Portland Cement.
- B. American National Standards Institute (ANSI)
 - 1. ANSI B1.1 - Unified Inch Screw Threads (UN and UNR Thread Form).
 - 2. ANSI B16.1 - Cast Iron Pipe Flanges and Flanged Fittings.
 - 3. ANSI B18.2 - Square and Hex Bolts and Screws Inch Series Including Hex Cap Screws and Lag Screws.
- C. American Water Works Association (AWWA)
 - 1. AWWA C104 - Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.
 - 2. AWWA C110 - Ductile-Iron and Gray-Iron Fittings, 3-In Through 48-In (75mm Through 1200mm) for Water and Other Liquids.
 - 3. AWWA C111 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
 - 4. AWWA C115 - Flanged Ductile-Iron Pipe with Threaded Flanges.
 - 5. AWWA C150 - Thickness Design of Ductile-Iron Pipe.
 - 6. AWWA C151 - Ductile-Iron Pipe, Centrifugally Cast for Water or Other Liquids.
 - 7. AWWA C600 - Installation of Ductile-Iron Water Mains and Their Appurtenances.
 - 8. AWWA C606 - Grooved and Shouldered Joints.
 - 9. AWWA C651 - Disinfecting Water Mains.
- D. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.06 QUALITY ASSURANCE:

- A. Each length of ductile iron pipe supplied for the project shall be hydrostatically tested at the point of manufacture to 500 psi for a duration of 10 seconds per AWWA

C151. Testing may be performed prior to machining bell and spigot. Failure of ductile iron pipe shall be defined as any rupture of the pipe wall. Certified test results shall be furnished in duplicate to the Engineer prior to time of shipment.

- B. All ductile-iron pipe and fittings to be installed under this project shall be inspected and tested at the foundry as required by the standard specifications to which the material is manufactured. Furnish in duplicate to the Engineer sworn certificates of such tests and their results prior to the shipment of the pipe.
- C. All pipe and fittings to be installed under this Contract may be inspected at the plant for compliance with these Specifications by an independent testing laboratory selected by the Owner, at the Owner's expense.
- D. Inspection of the pipe and fittings will also be made by the Engineer or representative of the Owner after delivery. The pipe shall be subject to rejection at any time on account of failure to meet any of the Specification requirements, even though sample pipes may have been accepted as satisfactory at the place of manufacture. Pipe rejected after delivery shall be marked for identification and shall be removed from the job.
- E. All pipe and fittings shall be permanently marked with the following information:
 - 1. Manufacturer, date.
 - 2. Size, type, class, or wall thickness.
 - 3. Standard produced to (ANSI/AWWA, ASTM, etc).

1.07 DELIVERY, STORAGE AND HANDLING:

- A. See Section 01002 for supplemental conditions.
- B. Care shall be taken in loading, transporting and unloading to prevent injury to the pipe or coatings. Under no circumstances shall the pipe be dropped or skidded against each other. Slings, hooks, or pipe tongs shall be padded and used in such a manner as to prevent damage to the exterior surface or internal lining of the pipe.
- C. Materials, if stored, shall be kept safe from damage. The interior of all pipe, fittings and other appurtenances shall be kept free from dirt or foreign matter at all times.
- D. Pipe shall not be stacked higher than the limits recommended by its manufacturer. The bottom tier shall be kept off the ground on timbers, rails, or concrete. Stacking shall conform to manufacturer's recommendations.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. Pipe

1. Ductile iron pipe shall conform to AWWA C115, C110 and C151 standards. Flanged pipe shall be Thickness Class 53 as per AWWA C150.
2. Pipe shall be supplied in standard lengths as much as possible.
3. Ductile iron pipe shall be as manufactured by U.S. Pipe and Foundry Company, Inc.; American Cast Iron Pipe Company or approved equal.

B. Joints

1. Ductile iron pipe shall have flanged joints. Flange shall be flat face type, unless otherwise noted, meeting requirements of ANSI B16.1 Class 150.
2. Flange gasket shall be full face type per AWWA C111 to provide positive sealing for the flanged ductile iron joints. Thickness shall be 1/8-in unless otherwise indicated.
3. Assembly bolts shall be square headed carbon steel machine bolts with hexagon nuts per ANSI B18.2. Thread shall conform to ANSI B1.1. Bolt length shall be such that after joints are assembled, the bolts shall protrude through the nuts, but not more than 1/8-in.
4. Grooved joints shall conform to AWWA C606 standard flexible couplings and shall be Style 31 couplings as manufactured by Victaulic Company of America or approved equal.
5. Sleeve type couplings shall be Dresser Style 38 or 138 as manufactured by Dresser Industries or approved equal.
6. Flanged coupling adaptors shall be Smith-Blair Type 913 or approved equal.

C. Fittings

1. Pipe fittings shall be ductile iron with a pressure rating of 150 psi. Fittings shall meet the requirements of AWWA C110 as applicable. Fittings shall have the same pressure rating, as a minimum, of the connecting pipe.

D. Interior Lining

1. Ductile iron pipe and fittings shall be bituminous coated on the outside and lined with Protecto 401 Ceramic Epoxy in the inside.
2. Coating on the outside shall be asphaltic coating approximately 1 mil thick. The finished coating shall be continuous, smooth, neither brittle when cold or sticky when exposed to the sun, and shall be strongly adherent to the iron.
3. Protecto 401 Ceramic Epoxy interior lining shall conform to ASTM E-96-99, ASTM B-117, ASTM 6-95, ASTM D-714-87.

4. The interior of the pipe shall receive 40 mils nominal dry film thickness of Protecto 401. Lining application, inspection, certification, handling and surface preparation of the area to receive the protective coating shall be in accordance with the Protecto 401 manufacturer specification and requirements.

E. Exterior Coatings

1. Unless otherwise specified, all exposed exterior ferrous surfaces shall be painted with an applicable paint system as specified under Division 090000. Surface preparation and application thereof shall be in conformance with applicable provisions of Division 090000.
2. All pipe and fittings exposed to view in the finished work shall not receive the standard asphalt coating but shall be primed on the outside in accordance with Section 09900. All other pipe and fittings shall be shop coated on the outside with bituminous coating in accordance with the above referenced specifications and will not require any other coating. If it is necessary to use bituminous coated pipe in exposed areas, the coating shall be completely removed by blast cleaning and the cleaned surfaces shall be immediately primed as specified in Section 099113.

F. Pipe Hangers and Supports

1. Pipe hangers and supports shall be provided at suitable distance along the pipeline regardless whether they are shown or not shown on the Drawings.
2. Pipe hangers and supports shall be as specified in Section 400507.

PART 3 - EXECUTION

3.01 PIPE INSTALLATION:

A. General

1. All piping and fittings shall be installed true to alignment and rigidly supported. Anchorage shall be provided where required. Any damage to linings shall be repaired to the satisfaction of the Engineer before the pipe is installed. Each length of pipe shall be cleaned out before installation. All of manufacturer's recommendations shall be complied with.
2. The deflection at joints shall not exceed that recommended by the pipe manufacturer. Fittings, in addition to those shown on the Drawings, shall be provided, if required, in areas where conflict exists with the existing facilities.
3. When pipe cutting is acceptable to the Engineer, the cutting shall be done by abrasive saw, leaving a smooth cut at right angles to the axis of the pipe. Any damage to the lining shall be repaired to the satisfaction of the Engineer. Field cut ends shall be sealed with Protecto 401 (or for potable water, approved epoxy) in accordance with manufacturer's instructions.
4. Ductile iron and fittings shall be installed in accordance with requirements of AWWA C600 modified.

- B. Jointing
 - 1. Flanged joints shall be made using gaskets, bolts, bolt studs with a nut on each end, or studs with nuts where the flange is tapped. The number and size of bolts shall conform to the same ANSI Standard as the flanges.
 - 2. Bolts in flanged joints or mechanical joints shall be tightened alternately and evenly.
 - 3. Sleeve type couplings and grooved joints using split ring couplings shall be installed in accordance with the procedures recommended by their respective manufacturers.
- C. All pipe and appurtenances connected to equipment shall be supported in such a manner as to prevent any strain being imposed on the equipment. When manufacturers have indicated requirements that piping loads shall not be transmitted to their equipment, submit a certification stating that such requirements have been complied with.
- D. Sleeves of proper size shall be installed for all pipes passing through floors or walls.
- E. Sleeves and wall pipes shall have thrust collar located at the mid-depth of wall.
- F. Concrete inserts for hangers and supports shall be furnished and installed as recommended by the manufacturer or as specified herein or as shown on the Drawings. The inserts shall be set in accordance with the requirements of the piping layout and the Contractor shall verify their locations from approved piping layout drawings and the structural drawings.

3.02 TESTING:

- A. All piping shall be subject to acceptance tests as described in Division 400500. Provide all necessary utilities, labor and equipment for flushing and testing and dispose all waste after the test including water.
- B. All pipe and fittings shall be pressure tested as described in Division 400500 using water to 1.5 times the working pressure.
- C. Correct any leakage and repair any damage to the pipe and pipe appurtenances or to any structures resulting from, or caused by tests. All leaks shall be repaired and lines retested.

3.03 CLEANING:

Clean all of the pipe by flushing with water or other means to remove all dirt, stones, pieces of wood, or other material which may have entered during the construction period. All debris shall be removed from the pipeline. The lowest segment outlet shall be flushed last to assure debris removal.

3.04 PIPE MARKING:

All exposed piping exterior and interior shall be marked in accordance with the requirements of Division 400000.

END OF SECTION

SECTION 400520

PIPE TESTING – GENERAL REQUIREMENTS

PART 1 - GENERAL

1.01 SCOPE:

This Section specifies the general requirements for testing the various piping systems shown on the Drawings and specified elsewhere in these Specifications. Refer to Piping and System Section specs for actual test parameters.

1.02 RELATED WORK:

Pipe, joints, piping systems and appurtenances are specified in other Sections of Division 400500.

1.03 SUBMITTALS:

A. Test Records

1. Records shall be maintained of all tests performed.
2. Test records shall include:
 - a. Date of Testing
 - b. Identification of Piping Tested
 - c. Test Fluid
 - d. Test Pressure
 - e. Signature of Contractor
3. If leaks are found, they shall be noted, on the record. After correction, retest as specified for original test.
4. Records of test shall be maintained by the Contractor and 4 copies furnished to the Engineer.

1.04 REFERENCE STANDARDS:

- A. American National Standards Institute (ANSI)
ANSI B31 - Code for Pressure Piping, B31 Interpretation.
- B. American Society of Testing Materials (ASTM)
ASTM F1417 - Standard Test Method for Installation and Acceptance of Plastic Gravity Sewer Lines Using Low-Pressure Air
- C. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

PART 2 - PRODUCTS

2.01 TEST FLUIDS:

Hydrostatic Test – Potable water should be used as the test fluid only.

Service Pressure Test – Potable water should be used as the test fluid only.

Pneumatic Test - Compressed air shall normally be used. Other gases may be used when specified or directed by the Engineer. Test Pressure shall be per ASTM F1417.

2.02 TEST EQUIPMENT:

A. Hydrostatic Test

1. Water - Of sufficient capacity to deliver the required test pressure.
2. Strainer - On inlet side of the pump to prevent foreign matter from entering the system.
3. Valves - Shall be provided on the suction and discharge side of the pump.
4. Heater - To allow heating of the test fluid when elevated temperatures are required for test.
5. Relief Valve - Set at a pressure to relieve at 20 to 25 percent above the required test pressure.
6. Pressure Gage(s) - Capable of reaching 50 percent over the test pressure. These should be located at the pump discharge and any other place deemed convenient by the Contractor.
7. Pressure gages and relief valves shall be checked for accuracy before use in test procedures.

B. Service Pressure Test

1. A pressure gage capable of registering 25 psi over the design pressure shall be installed downstream from the supply shut-off valve if one is not included in the system.

C. Pneumatic Test

1. Building supply air to deliver the required test pressure if available or provide a compressor capable of the required test pressure.
2. Valves shall be provided on the discharge side of the pump.
3. Relief valve to relieve at 10 - 15 percent over the test pressure.
4. Pressure gage(s) capable of reaching 50 percent over the test pressure. A gage shall be located on the pump discharge and other location as required.

PART 3 - EXECUTION

3.01 HYDROSTATIC TEST:

- A. This test specification shall be used to hydrostatically test piping systems for structural integrity and leaks. The test shall be performed at ambient temperature unless otherwise specified.
- B. Preparation for Test:
 - 1. Determine the fluid to be used for the test, and, if other than ambient temperature is required, what the test temperature will be.
 - 2. When a fluid other than water is used for a test, the equipment used for the test shall be of a material compatible with the test fluid. Normally this would be equal to the piping material.
 - 3. Vents shall be provided at the high points of the system and drains provided where means of venting or draining do not exist.
 - 4. Remove or block off, all relief valves, rupture discs, alarms, control instruments, etc. that shall not be subjected to the test pressure.
 - 5. All discs, balls, or pistons from check valves shall be removed if they interfere with filling of the system. Open all valves between inlet and outlet of the section to be tested.
 - 6. Connect pump and provide temporary closures for all of the external openings in the system. Use caution to insure that the closures are properly designed and strong enough to withstand the test pressure.
 - 7. All joints, including welds, are to be left uninsulated and exposed for examination during test.
 - 8. A joint previously tested in accordance with this specification may be covered or insulated.
 - 9. Piping designed for vapor or gas shall be provided with additional temporary supports, if necessary, to support the weight of the test liquid.
 - 10. Expansion joints shall be provided with temporary restraint for additional pressure under test or shall be isolated from the test.
 - 11. Flanged joints, where blanks are inserted to isolate equipment during the test, need not be tested.
- C. The hydrostatic test pressure shall be 1-1/2 times the design pressure unless otherwise specified in the System Specification Section.
- D. Test Procedures
 - 1. Allow the test fluid to enter the system. Open vents to allow displacement of all entrapped air. For all pipelines exceeding 500-ft in length, the maximum rate of filling shall be limited to that which produces a maximum nominal flow velocity of one foot per second in the pipe to be tested.

2. Close vents and restrict personnel in the test area to those involved in the test.
3. Raise the pressure slowly with the pump until the predetermined test pressure is reached. Maintain pressure for duration of time specified in System Specification Section, keeping personnel at a safe distance.
4. Reduce the pressure about 20 percent and hold it at that point while the entire system is carefully inspected for leaks, cracks, or other signs of defects.
5. If defects are found, the pressure shall be released, the system drained, the defects corrected and the test repeated.
6. After a satisfactory test has been completed, the line shall be drained.

E. Flushing

1. Lines tested with potable water shall be completely drained.
2. Lines shall be flushed with potable water, after test.

3.02 SERVICE PRESSURE TEST:

- A. This test specification shall be used to test piping systems using service pressure and the fluid for which the system is used. It shall not be used to test piping systems conveying combustible or flammable liquids or systems that comply with ANSI B31 codes. Insulated lines shall have all joints left exposed until completion of the test.
- B. The test pressure shall be equal to the maximum pressure that the line will be subjected to under normal operating conditions as determined by the Engineer.
- C. Test Procedures
 1. Liquids
 - a. See that all personnel not involved in the test vacate the area.
 - b. Allow the system fluid to enter the system slowly while venting the air at the extreme far and uppermost points. For all pipelines exceeding 500-ft in length, the maximum rate of filling shall be limited to that which produces a maximum nominal flow velocity of one foot per second in the pipe to be tested.
 - c. When the system is full and all air is vented, close the vents.
 - d. Allow the pressure in the system to build up to the full line pressure.
 - e. Inspect entire system for leaks.
 2. Gas or Vapor (Including Compressed Air and Steam)
 - a. See that all personnel not involved in the test vacate the area.

- b. In systems that do not have a pressure gage near the main shut-off valve, a gage shall be installed.
 - c. Allow the system fluid to enter the system slowly until the full operating pressure is reached.
 - d. Shut off main supply valve. Observe the gage for 15 minutes. The pressure gage shall not drop during this time.
 - e. If the gage drops, indicating the presence of leaks, the systems shall be inspected visually and, if necessary, with soap suds or commercially available leak detectors to locate the leak(s).
3. If leaks are found, the lines shall be relieved of pressure, purged if necessary and repaired. Tests shall be repeated for repaired sections.

3.03 PNEUMATIC TEST:

This procedure for a pneumatic test of piping systems shall be used for all gravity sewer lines. The Contractor is responsible for all costs associated with testing.

A. Safety

- 1. All pneumatic tests shall be done under the supervision of Contractor and in the presence of the Owner.
- 2. Only those people actively participating in the test shall be allowed in the test area.
- 3. Safety glasses and hard-hats must be worn.

B. Test Procedures

Test procedure shall be per ASTM F1417 - Standard Test Method for Installation and Acceptance of Plastic Gravity Sewer Lines Using Low-Pressure Air, latest revision.

3.04 CHLORINATION OF POTABLE WATER PIPELINE:

- A. Before being placed in service, all new potable water pipelines shall be chlorinated in accordance with AWWA C601, "Standard Procedure for Disinfecting Water Mains." The approval of the procedure by the Engineer shall be obtained in advance.
- B. The location of the chlorination and sampling points shall be determined under this Section.
- C. The general procedure for chlorination shall be first to flush all dirty or discolored water from the lines, and then introduce chlorine in approved dosages through a tap at one end to obtain a chlorine residual of 50 mg/l, while water is being

withdrawn at the other end of the line. The chlorine solution shall remain in the pipeline 24 hours.

- D. Following the chlorination period, all treated water shall be flushed from the lines at their extremities, and replaced with water from the distribution system. Bacteriological sampling and analysis of the replacement water may then be made by the Owner in full accordance with AWWA Standard C601. Rechlorination will be required, if necessary and the line shall not be placed in service until the requirements of the State Regulatory Agency are met.
- E. Special disinfecting procedures shall be used in connections to existing mains, and where the method outlined above is not practical.
- F. Chlorinated water and other water used for flushing shall be directed to the treatment plant influent or shall be dechlorinated and discharged as directed by the Engineer. No discharges shall be permitted to surface waters, streams, drainageways or storm drains.

END OF SECTION

SECTION 400523

STAINLESS STEEL PIPE AND FITTINGS

PART 1 - GENERAL

1.01 SCOPE OF WORK:

Furnish all labor, materials, equipment and incidentals required and install and test all stainless steel pipe and fittings as shown on the Drawings and specified herein.

1.02 RELATED WORK:

- A. Yard piping is included in Division 331100 and 400500
- B. Concrete work is included in Division 030000.
- C. Field painting is included in Division 090000.
- D. Pipe hangers and supports are included in Section 400507.
- E. Valves and appurtenances are included in Section 400562.
- F. Steel pipe and fittings are included in Section 400524.

1.03 DESCRIPTION OF SYSTEM:

- A. Stainless steel piping shall be installed for use in locations as shown on the Drawings.
- B. In lieu of using steel or ductile iron pipe for interior above grade applications, the Contractor may elect to use stainless steel pipe as specified herein. When this alternative is selected, the Contractor shall furnish all labor, materials, equipment and incidentals necessary to install and test all stainless steel pipe and fittings as specified herein.
- C. The equipment and materials specified herein are intended to be standard types of stainless steel pipe and fittings for use in transporting wastewater, water, and air (low pressure).

1.04 QUALIFICATIONS:

Stainless steel pipe and fittings shall be furnished by manufacturers who are experienced in the manufacture of the items to be furnished. The pipe and fittings shall be designed,

fabricated, and installed in accordance with the best practices and methods and shall be suitable for the intended service.

1.05 SUBMITTALS:

- A. Shop drawings, including piping layouts and schedules, shall be submitted to the Engineer for review and shall include dimensioning, fittings, locations of valves and appurtenances, joint details, methods and locations of supports, and all other pertinent technical specifications for all piping to be furnished.
- B. Shop drawing submittals for piping under this Section shall include all data and information required for the complete piping systems. All dimensions shall be based on the actual equipment to be furnished. Types and locations of pipe hangers and/or supports shall be shown on the piping layouts for each pipe submittal.

PART 2 - PRODUCTS

2.01 GENERAL:

- A. Pipe and fittings shall be seamless or welded, austenitic stainless steel pipe Grade Type 304L conforming to ASTM A-240 and ANSI B36.19. Finish on sheets shall be 2B and finish on plates shall be No. 1.
- B. All pipe and fittings shall be manufactured in accordance with ASTM A-778 or A-774 from sheet or plate to I.P.S. dimensions. Pipe for the low pressure air systems shall be designed for a rated working pressure of at least 50 psi at 250 F and shall be ANSI B36.19, Schedule 5S, minimum.
- C. Stainless steel nuts, anchor bolts, brackets, fasteners, supports, etc. shall be schedule 40, type 316.
- D. All pipe shall be fabricated by die forming or rolling true to dimension and round within a tolerance of plus or minus 1/16-inches. The two edges of sheet shall be brought to line so as not to leave a shoulder on the inside of the pipe. Ends of pipe and fittings shall be perpendicular to the longitudinal axis. Pipes shall be straight within maximum of 1/8-inch deviation over 10 feet. All pieces shall be marked with gage and type of stainless steel.
- E. All fittings shall be fabricated of the same material as the pipe and of wall thicknesses at least as heavy as the pipe. Fittings shall be reinforced as required to withstand the internal pressure and provide structural integrity. Elbows greater than 16 inches in diameter shall be formed smooth or made up of mitered straight sections welded together in at least five (5) segments. Elbows 16 inches in

diameter or less shall be formed smooth. Dimensions of fittings shall conform to ANSI B16.9.

- F. All welding of pipe, fittings, and subassemblies shall be completed in the factory. Field welding shall not be permitted. Welding shall be performed by qualified welders in conformance with standard procedures for the application, by the shielded arc, inert gas, MIG or TIG method. Filler wire shall be added to all welds to provide for a cross section and weld metal equal to or greater than the parent metal. Weld deposit shall be smooth and evenly distributed and have a crown of no more than 1/16 inches on both sides of the weld. No cracks or crevices shall be allowed. Butt welds shall have full penetration to interior and exterior of the joint. Excessive weld deposits, slag, spatter, and projections shall be removed by grinding.
- G. After manufacture, all pipe and fittings shall be passivated by immersion in a pickling solution of six percent (6%) nitric acid and three percent (3%) hydrofluoric acid at 140° F for a minimum of fifteen (15) minutes. The surface shall be free of iron particles or other foreign material. A complete neutralizing operation shall follow by immersion in a trisodium phosphate rinse.
- H. The welds of shop welded assemblies shall be cleaned and scrubbed with pickling solution and thoroughly rinsed after fabrication.
- I. Joints for field assembly shall be prepared for either flanged or flexible type coupling. Pipe components may be shop welded into assemblies for field installation. Field welding will not be permitted. Flange joints are shown on the Drawings at connections to equipment, fittings, and valves. Flexible type couplings are shown where required for disassembly of piping for servicing and pipe flexibility. All other joints are shown as welded; however, additional flanged or flexible type coupling joints shall be provided as required to join welded shop assemblies.
 - 1. Flanged joints shall be made up with slip-on type rolled angle face rings, with wall thickness not less than 0.187-in welded to the pipe end. The rolled angle faces shall be true and perpendicular to the axis of the pipe or fittings. Backing flanges for face rings shall be of ductile iron, drilled to ANSI B16.1 Class 125 standard, and minimum thickness of 7/8-inch for pipe 20-inch diameter or less, and 1-in for pipe 24-inch diameter and larger. Gaskets for flanged joints shall be of materials and construction suitable for the intended application and service. Flange bolts and studs shall be of number and size in accordance with ANSI B16.1. All bolts, washers, nuts, and other hardware for flange bolting shall be Type 304 stainless steel.
 - 2. Flexible type couplings for joints shall be as specified herein. Pipe shall be plain end for flexible couplings and shall have welded-on attachments

for joint restraint where required. All flexible couplings in pump discharge pipes and/or other pressure pipes shall have at least two (2) bolt diameter tie rods connecting adjacent flanges. Each tie rod shall be installed to restrain movements of the pipe along its axial direction. Adjacent flanges shall be installed and shall be located far enough apart to permit dismantling of the flexible coupling without dismantling both adjacent flanges.

2.02 FLEXIBLE COUPLINGS:

- A. Victaulic and flexible couplings shall be installed as required to permit removal of pipe sections and as shown on Drawings. Flexible couplings shall be Style 38 as manufactured by Dresser Industries; F-2533 as manufactured by Clow Corp; or approved equal. Victaulic couplings shall be Style 77 as manufactured by Victaulic Company of America; Series 300 as manufactured by Worth American Pipe Products Company, Northboro, MA, or approved equal.
- B. Dielectric gaskets shall be used with all flexible couplings to separate dissimilar metals. The gasket shall be installed so as to provide electrical insulation between the pipe and flexible coupling, thus reducing chances of cathodic reaction between these two members.

2.03 PIPE SLEEVES:

- A. Sleeves for pipe passing through floors and walls shall be galvanized Schedule 40 steel pipe conforming to ASTM A120. Sleeve dimensions shall conform to the details shown on the Drawings. Sleeves shall be flush with walls and ceilings but shall extend above the floor as shown on the Drawings in conformance with the seal manufacturer's recommendations. Sleeves for use with mechanical type seals shall be sized in conformance with the seal manufacturer's recommendations.
- B. A watertight seal at all wall sleeves shall be obtained using expandable rubber seal rings as shown on the Drawings. These seal rings shall be the modular mechanical type consisting of synthetic rubber links shaped to continuously fill the annular space between the pipe and wall sleeve. Links shall be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and nut. After the seal assembly is positioned in the sleeve, tightening of the bolts shall cause the rubber sealing elements to expand and provide a watertight seal between the pipe and sleeve. The watertight seal shall be effective against a hydrostatic head of at least 40 feet. The seal shall also be constructed so as to provide electrical insulation between the pipe and wall, thus reducing chances of cathodic reaction between these two members.

2.04 INSULATION:

- A. Insulation shall be installed on all low pressure air piping at the Air Backwash Blower, including inlet and discharge silencers for the positive displacement blowers, but not including flexible connections. Insulation shall extend to an elevation 8'-0" above the floor on the Blower discharge. The insulation shall be equal to Fibrex Inc. Refractory Fiber Pipe Covering, 1-inch thick, held in place with stainless steel banding, and covered with a 0.016 to 0.020-in aluminum jacket lapped a minimum of 3-inch and secured with screws. The aluminum jacket shall be separately applied at the job site. Flanges, fittings, and valves shall be insulated with MF pipe covering material cut to fit. The flexible sections shall be protected by a removable expanded metal guard to provide ventilation and to prevent personal injury from a burn.

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. Piping systems within the buildings and structures shall be installed as shown on the Drawings, with ample clearances and allowances for expansion or contraction, operation of all doors and windows, mechanical equipment, etc.; without blocking aisle space. Pipe supports shall be installed at proper intervals to insure uniform alignment and structural stability. These supports are to be installed so as to relieve all undue stress or strain that may occur on the piping. Where pipes run parallel and at the same elevation, they may be grouped together and supported from a common trapeze-type hanger, provided that the hanger rods are increased sufficiently to support the extra weight.
- B. Sleeves or wall castings of the size shown on the Drawings, specified, or required by the Engineer, shall be installed for all pipes passing through concrete or masonry walls or floors.
- C. Inserts for pipe hangers and supports shall be installed on forms before concrete is poured. Before setting these items, the Contractor shall check all plans and figures which have a direct bearing on the pipe location and shall be responsible for the proper location of pipes during the construction of the structures.
- D. Care shall be taken in bolting flanged joints so that there is no restraint on the opposite end of the pipe or fitting which would prevent uniform gasket pressure at the connection or cause unnecessary stresses in the equipment flange. Bolts shall be tightened gradually at a uniform rate and in a program that will result in uniform gasket pressure. The bolt tightening sequence shall be as recommended by the pipe manufacturer.

- E. When cutting by pipe is required, the cutting shall be done by machine in a neat workmanlike manner without damage to the pipe. Cut ends shall be smooth and at right angles to the axis of the pipe.
- F. After installation, completed pipe lines shall be washed clean with steam or hot water to remove any foreign material picked up during transport.

3.02 TESTING:

- A. After installation, all piping shall be tested for a minimum of two hours at twice the design operating pressure or as directed by the Engineer. The low pressure air piping shall be tested at a pressure of 50 psi. Any piping used for conveyance of water in the pipe gallery in lieu of Ductile Iron or Steel shall also be tested to 50 psi, except if used on the washwater system where it shall be tested to 100 psi. Defective joints shall be repaired and retested to the Engineer's satisfaction. It is the intent of this specification that all piping be installed "gas" and "water" tight. Any and all joints found to be otherwise shall be promptly repaired and faulty materials removed from the project site.
- B. The Contractor shall furnish all power, water, air, labor and appurtenances required to complete these tests.

END OF SECTION

SECTION 400524

STEEL PIPE AND FITTINGS

PART 1 - GENERAL

1.01 SCOPE OF WORK:

- A. Furnish all labor, materials, equipment, and incidentals required and install, complete and ready for operation, and field test, all non- buried steel piping as shown on the Drawings and specified herein.
- B. In lieu of using ductile iron pipe, steel pipe as hereinafter specified may be substituted for all buried concrete encased pipe located under new structures.
- C. Steel pipe shall include black steel and galvanized steel pipe and fittings.

1.02 RELATED WORK:

- A. Yard piping is included in Division 331100 and 400000.
- B. Field painting is included in Section 099113.
- C. Ductile iron pipe and fittings are included in Section 400519.
- D. Valves and appurtenances are included in Section 400562
- E. Pipe hangers and supports are included in Section 400507.
- F. General Requirements are included in Section 400510.

1.03 SUBMITTALS:

- A. Submit to the Engineer within thirty days after execution of the Contract a list of materials to be furnished, the names of the suppliers and the date of delivery of materials to the Site.
- B. Shop Drawings including piping layouts and schedules shall be submitted to the Engineer in accordance with Sections 01002, and shall include dimensioning, fittings, locations of valves and appurtenances, joint details, methods and locations of supports, and all other pertinent technical specifications for all piping to be furnished.

- C. Shop drawing submittals for piping under this Section shall include all data and information required for each piping system. All dimensions shall be based on the actual equipment to be furnished. Types and locations of pipe hangers and supports shall be shown on the piping layouts for each piping submittal.
- D. Prior to shipment of pipe, submit certified test reports that the pipe for the Contract was manufactured and tested in accordance with the AWWA standards specified herein.
 - 1. Internal Pressure
 - a. Design Pressure for areas where steel piping is allowed (raw water, and filtered water) is 100 psi.
 - b. Water Hammer plus Design pressure is 150 psi.
 - c. Internal Test Pressure is 150 psi.
 - d. Minimum Wall thickness (in) will be $D/t = 230$, but in no case less than 0.25 inches.
 - 2. Pipe and fittings shall be designed with a maximum deflection of the steel cylinder of 3 percent of the internal diameter.
 - 3. The minimum wall thickness shall be 0.25 inches or $D/t = 230$, whichever is greater. The wall thickness shall be increased, as required, at all bends, fittings and anchorage locations where thrust is transmitted by the pipe.

1.04 REFERENCE STANDARDS:

- A. American Society for Testing and Materials (ASTM)
 - 1. ASTM A47 - Standard Specification for Ferritic Malleable Iron Castings.
 - 2. ASTM A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 - 3. ASTM A105 - Standard Specification for Forgings, Carbon Steel, for Piping Components.
 - 4. ASTM A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - 5. ASTM A234 - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.

6. ASTM A307 - Standard Specification for Carbon Steel Bolts and Studs 60,000 psi Tensile Strength.
 7. ASTM A714 - Standard Specification for High-Strength Low-Alloy Welded and Seamless Steel Pipe.
- B. American National Standards Institute (ANSI)
1. ANSI B16.1 - Cast Iron Pipe Flanges and Flanged Fittings
 2. ANSI B16.5 - Pipe Flanges and Flanged Fittings
 3. ANSI B16.9 - Factory-Made Wrought Steel Buttwelding Fittings
- C. American Welding Society (AWS)
- D. American Water Works Association (AWWA)
1. AWWA C206 - Field Welding of Steel Water Pipe.
- E. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 QUALITY ASSURANCE:

- A. All steel pipe and fittings shall be furnished by manufacturers who are fully experienced, reputable and qualified in the manufacture of the items to be furnished. The pipe and fittings shall be designed, constructed and installed in accordance with the best practices and methods and shall comply with these Specifications as applicable.
- B. Steel pipe and fittings shall conform to all applicable standards of ASTM, ANSI and AWWA.

PART 2 - PRODUCTS

2.01 MATERIALS:

- A. Pipe
1. Pipe 6 inch and greater in diameter shall be seamless pipe or fabricated from steel sheets conforming to ASTM A-570 Grade 36 plates conforming to ASTM-283 Grade C or D, or ASTM A-572 Grade 42 or manufactured to meet the requirements of ASTM A-53 Grade B or ASTM A-139 Grade

A, B, or C. All pipe shall be manufactured in conformance with AWWA standard specification C-200 and AWWA Manual M-11.

2. Pipe and fittings 4 inch and over and used as a liquid carrier shall be cement-lined in the shop on the inside in accordance with AWWA Specification C205.
3. Pipe 4 inch and smaller shall be standard weight conforming to ASTM A-53 and shall be galvanized.
4. Pipe for the sodium bicarbonate fill line shall be 4-in inside diameter seamless steel pipe Schedule 40 wall thickness ASTM A53B. Piping shall be installed with a minimum bend radius of 4 feet.

B. Fittings

1. Fittings for pipe 6 inch and greater shall conform to AWWA C208 and ANSI B16.9 and shall be seamless or welded. Fittings for pipe 5 inch or less shall be standard malleable iron, 150 lb. fittings threaded for standard screwed joints.
2. All fittings shall be designed to have the same strength as the piping, and reinforcing rings or saddles shall be provided where required.

C. Joints

1. Field welding of joints or flanges will not be permitted except for below slab pipe that will be encased in concrete. Joints for below slab pipe to be encased in concrete may be field welded only to the extent necessary to facilitate delivery of pipe in manageable lengths (20 feet or longer or as approved by the Engineer). All field welding shall be in accordance with the AWS. Welding for restrained joints shall be a full fillet weld for the entire circumference in accordance with AWWA C206. During welding the coating shall be protected by draping an 18-inch wide strip of heat resistant material over the top half of the pipe on each side of the coating holdback to avoid damage to the coating by hot weld splatter. No welding ground shall be made on the coated part of the pipe. Sections of pipe and fittings may be shop welded prior to delivery. Joints must be beveled.
2. Joints for pipe and fittings 5 inch or less shall be threaded for standard screwed joints. Joints for pipe and fittings 6 inch or greater shall be joined by harnessed sleeve type couplings, mechanical couplings or flanges. Flanged connections shall be used where indicated on the Drawings or as otherwise required for connection to flanged valves, fittings, and appurtenances.

3. Flanges for pipe and fittings 4 inch and larger shall conform to AWWA C207, Class D and ANSI B16.5 and shall be slip-on type.
 - a. Flanges shall have raised faces on the gasket surface machined to a spiral serrated finish. Flanges shall be either back-faced or spot-faced around each bolt hole.
 - b. Flanges shall be double welded to the pipe with a strength fillet weld joining the flange hub to the pipe and a seal fillet weld inside the flange at the pipe end.
 - c. Bolts for flange bolting shall be hex head cap bolts conforming to ANSI B18.2.1, coarse threads, Class 2A fit, manufactured of ASTM A307, Grade B carbon steel.
 - d. Ring gaskets for flanged connections shall be of approved composition suitable for the required service. For cold water service, gaskets shall be highest grade duck or wire-inserted rubber.
4. Flanges for pipe fittings 3-1/2 inch and less shall be steel, 150 lb. ANSI standard flat face flanges of the threaded type. Flanges shall be spot faced on the back around each bolt hole. Bolts and gaskets shall be as specified in Paragraph 2.01C-3.
5. Sleeve-type couplings shall be as specified in Section 400520.
6. Steel pipe and fittings joined by mechanical couplings shall be grooved to rigid dimensions for 3 inch to 24 inch size, and shouldered for pipe over 24 inch in diameter in accordance with the manufacturer's recommendations. Mechanical couplings shall be as specified in Section 230500. All couplings shall be galvanized and shall be furnished with plated bolts and nuts. Couplings shall be furnished with gaskets suitable for potable water service.

PART 3 - EXECUTION

3.01 HANDLING PIPE AND FITTINGS:

- A. Pipe shall be handled, stored and shipped in a manner that will prevent damage. Pipe shall be handled with wide belt slings or rubber padded forklifts. Chains, cables or other equipment likely to cause damage to the pipe or coating shall not be used. Pipe shall be stored on padded skids, sand or dirt berms so that it will not be damaged. Pipe and fittings shall not be dropped. All pipe and fittings shall be examined before installing, and no piece shall be installed which is found to be

defective.

- B. If any piece is discovered damaged after it has been installed, it shall be removed and replaced with a sound pipe in a satisfactory manner. All pipe and fittings shall be thoroughly cleaned before installing and shall be kept clean until they are used in the work.

3.02 INSTALLATION:

- A. Steel piping shall be installed true to alignment and rigidly supported.
- B. Sleeves of proper size shall be installed for all pipes passing through floors or dry walls.
- C. All threads shall be clean, machine cut, and all pipe shall be reamed before installation. As each length of pipe is installed, it shall be up-ended and rapped to dislodge dirt and scale.
- D. Screwed joints shall be made up with good quality thread compound and applied to the male thread only. After having been set up, a joint must not be backed off unless the joint is completely broken, the threads cleaned and new compound applied. All joints shall be air tight.
- E. All piping 3 ½ inch or less shall have a sufficient number of unions to allow convenient removal of piping. Unions shall be compatible with pipe.
- F. When cutting of pipe is required, the cutting shall be done by machine in a neat workmanlike manner without damage to the pipe. Cut ends shall be smooth and at right angle to the axis of the pipe.

3.03 PAINTING:

- A. Pipe and fittings exposed to view in the finished work shall be shop primed on the outside. Finish painting and pipe marking is included in Division 090000, but it shall be part of the work of this Section to assist as required by the Engineer in identifying pipe contents, direction of flow and all else required for proper finish painting and marking of pipe.
- B. The interior of sleeve-type and mechanical couplings shall receive an epoxy coating meeting the requirements of AWWA C210.
- C. Steel pipeline which is to be encased in concrete shall be shop primed only. No final coating or wrapping will be required prior to placement of the concrete encasement.

3.04 TESTING:

- A. All steel pipe and fittings shall be shop tested in accordance with AWWA C200.
- B. After installation, all steel piping shall be hydrostatically tested in accordance with Section 400520 -for at least one hour at 150 psi.

3.05 DISINFECTION:

- A. All potable water lines shall be chlorinated in accordance with Section 400520.

END OF SECTION

SECTION 400531.13

PLASTIC PIPE AND FITTINGS

PART 1 - GENERAL

1.01 SCOPE OF WORK:

Furnish all labor, materials, equipment and incidentals required and install in the locations as shown on the Drawings, the plastic piping, fittings and appurtenances as specified herein.

1.02 RELATED WORK:

- A. Excavation and backfill for yard piping is included in Section 331100.
- B. Painting is included in Section 090000.
- C. Valves and appurtenances are included in Section 400562.
- D. Pipe hangers and supports are included in Section 400507.
- E. Chemical feed systems are included in Division 462000.

1.03 DESCRIPTION OF SYSTEM:

Piping shall be installed in the locations as shown on the Drawings.

1.04 QUALIFICATIONS:

All plastic pipe, fittings and appurtenances shall be furnished by manufacturers who are fully experienced, reputable, and qualified in the manufacture of the items to be furnished. The equipment shall be designed, constructed, and installed in accordance with the best practices and methods and shall comply with these Specifications.

1.05 SUBMITTALS:

- A. Shop drawings shall be submitted to the Engineer for review in accordance with Sections 01002 and shall include dimensioning and technical specification for all piping to be furnished.
- B. Submit to the Engineer, for approval, samples of all materials specified herein.

1.06 TOOLS:

Special tools, solvents, lubricants, and caulking compounds required for normal installation shall be furnished with the pipe.

PART 2 - PRODUCTS

2.01 PVC PIPE AND FITTINGS:

- A. PVC pipe shall be rigid, unplasticized polyvinyl chloride (PVC) pipe and shall be in accordance with ASTM D-1784 and ASTM D-1785, Class PVC 1120 in conformance with AWWA C-900, Class 150 psi, and as manufactured by Celanese Piping Systems, Chemtrol Division; Cabot Company; or approved equal.
- B. The pipe shall be suitable for field cutting, welding, bending and shall be Schedule 80 unless otherwise shown on the Drawings and of the sizes as shown on the Drawings.
- C. All pipe shall be bundled or packaged in such a manner as to provide adequate protection for the ends, threaded, or flanged, during transportation from the manufacturer.
- D. Fittings shall be the socket type for solvent welded joints as designated in ASTM D-2467 or D-2466, except where threaded as shown on the Drawings, and as designated in ASTM D-2464 or flanged as shown on the Drawings and shall be compatible with the pipe where installed. Flanges shall be furnished with $\frac{1}{8}$ -inch thick full-faced gaskets. Flange bolts and nuts shall be ASTM A276, Type 304 or 316 stainless steel.

2.02 POLYETHYLENE PIPE AND FITTINGS:

- A. The pipe shall be made from high density polyethylene resin compound qualified as Type III, Category 3, Class C by ASTM D1248 with a minimum density of 0.955.
- B. The polyethylene compound shall be suitably protected against degradation by ultraviolet light as required by ASTM D1603.
- C. If rework compounds are required, only those generated in the manufacturer's own plant from resin compounds of the same class and type from the same raw material supplier shall be used.
- D. Pipe shall be designed for a working pressure of 100 psi in accordance with ASTM D3035.

- E. Pipe shall be joined by the butt-fusion process as recommended by the manufacturer.
- F. Installation lengths shall be joined by the use of PVC insert adaptors with clamps. Clamps and screws shall be Type 304 stainless steel.
- G. Termination to pipes, valves, or fittings made of other material shall be by flanged or threaded PVC adaptors. The pipe adjacent to these joints and to the joints themselves must be rigidly supported for a distance of one pipe diameter beyond the joint.

2.03 PLASTIC HOSE:

- A. Plastic hose shall be of flexible PVC.
- B. PVC hose for use on the Lime and Fluoride systems shall be Goodall Rubber Co., Discharge Hose No. V0136, or approved equal.
- C. PVC hose for use on chlorine and activated carbon lines shall be Goodall Rubber Co., Suction Hose No. V0130 or approved equal.
- D. Hose shall be joined by PVC couplings. Hose connections to PVC pipe or other materials shall be by threaded PVC adaptor, male or female as required.

2.04 APPURTENANCES:

- A. Unions shall be of the same material as the pipe.
- B. Expansion joints shall be CPVC.

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. The installation of plastic pipe shall be strictly in accordance with the manufacturer's technical data and printed instructions.
- B. Joints for PVC pipe shall be solvent welded except flanged or threaded where required. In making solvent welded connections, clean dirt and moisture from pipe and fittings, bevel pipe ends slightly with emery cloth, if necessary, and apply solvent cement of the proper grade. Expansion joints shall be installed every 50 feet on long runs and in every straight run longer than 15 feet.
- C. Installation of valves and fittings shall be strictly in accordance with manufacturer's instructions. Particular care shall be taken not to overstress

threaded connections at sleeves. In making solvent weld connections the solvent shall not be spilled on valves or allowed to run from joints.

- D. All piping shall have a sufficient number of unions to allow convenient removal of piping and shall be as approved by the Engineer.
- E. Where plastic pipe passes through wall sleeves, joints shall be sealed with a mechanical sealing element as specified in Section 400509.
- F. All plastic pipe to metal pipe connections shall be made using flanged connections. Metal piping shall not be threaded into plastic fittings, valves, or couplings, nor shall plastic piping be threaded into metal valves, fittings or couplings.
- G. Concrete inserts for hangers and supports shall be furnished and installed in the concrete as it is placed. The inserts shall be set in accordance with the requirements of the piping layout and the Contractor shall verify their locations from approved piping layout drawings and the structural drawings.
- H. Polyethylene pipe used for alum discharge lines shall be installed in trench or as shown on the drawings. Contractor shall install in the maximum length possible from coils to minimize the number of joints. Pipe shall be snaked to allow for expansion and contraction as recommended by the manufacturer. Where shown on the drawings, pipe shall be pulled through PVC conduit in continuous lengths. No joints will be allowed in the conduit.
- I. Plastic hose shall be installed at the locations as shown on the drawings. It shall be supported continuously by cable trays. Where shown on the drawings, hose shall be installed in PVC conduit.

3.02 FIELD PAINTING:

Pipe normally exposed to view shall be painted and marked as specified in the Painting Section 099113. Engineer will assist in identifying pipe contents, direction of flow and all else required for proper marking of pipe.

3.03 INSPECTION AND TESTING:

- A. Testing of pipelines is specified in Section 400520.
- B. All pipelines shall remain undisturbed for twenty-four (24) hours to develop complete strength at all joints. All pipelines shall be subjected to a hydrostatic pressure test for 4 hours at full working pressure. All leaks shall be repaired and lines retested as approved by the Engineer. Prior to testing, the pipelines shall be supported in an approved manner to prevent movement during tests.

END OF SECTION

SECTION 400531.83

CHEMICAL HOSE AND APPURTENANCES

PART 1 - GENERAL

1.01 SCOPE OF WORK:

Furnish all labor, materials, equipment and incidentals required and install, in the locations as shown on the Drawings, the chemical hose and appurtenances as specified herein.

1.02 RELATED WORK:

- A. Field painting is included in Section 090000.
- B. Plastic pipe and fittings are included in Section 400531
- C. Pipe hangers and supports are included in Section 400507.
- D. Valves and appurtenances are included in Section 400562.
- E. Hose for use with wash hose stations is included in Section 400506.

1.03 SUBMITTALS:

- A. Submit to the Engineer, in accordance with Section 01002, shop drawings, including dimensioning and technical specifications for all chemical hose to be furnished. Submittals shall include layouts complete with locational dimensions and elevations.
- B. Complete description of chemical resistance of chemical hose and all appurtenances that will come in contact with chemicals as specified herein.
- C. Letter of Certification that chemical hose is compatible with chemical service intended.

1.04 QUALITY ASSURANCE:

- A. All chemical hose shall be furnished by manufacturers, who are fully experienced, reputable and qualified in the manufacturer of the chemical hose to be furnished. The materials shall be designed, constructed and installed in accordance with the best practices and methods and shall comply with this Section.

- B. The hose manufacturer shall guarantee that the hose supplied is adequate and suitable for the intended service.

1.05 MAINTENANCE:

- A. Special tools, if required for installation, shall be furnished with the chemical hose. Tools shall be packaged in a steel case, clearly and indelibly marked on the exterior to indicate equipment for which tools are intended.

PART 2 - PRODUCTS

2.01 GENERAL:

- A. The use of a manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired.
- B. Like items of materials/equipment shall be the end products of one manufacturer in order to provide standardization for appearance, operation, maintenance, spare parts and manufacturer's service.

2.02 MATERIALS:

- A. Provide type of hose lines as shown on the Drawings and as specified herein. Hose sizes refer to hose inside diameter.
- B. Length of hose shall be adequate for device or service intended.

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. The installation of chemical hose and appurtenances shall be strictly in accordance with the manufacturer's technical data and printed instructions.
- B. Chemical hose shall be connected to all valves and pipe using flanged connections per technical data and printed instructions of the manufacturer.

END OF SECTION

SECTION 400559

HYDRAULIC GATES

PART 1 - GENERAL

1.01 SCOPE OF WORK

Furnish all labor, materials, equipment, and incidentals required and install, complete and ready for operation, and field test, slide gates, operators, operating stems and appurtenances as shown on the Drawings and as specified herein.

1.02 RELATED WORK

- A. Concrete work is included under Division 030000. Wall thimbles and anchor bolts, however, shall be furnished and installed under this Section.
- B. Non-shrink grout is included in Division 036000.
- C. Field painting is included under Division 090000.
- D. Mechanical valves are specified under Division 400000.

1.03 SUBMITTALS

- A. Copies of all materials required to establish compliance with the Specifications shall be submitted in accordance with the provisions of Section 01002. Submittals shall include at least the following:
 - 1. Complete description of all materials.
 - 2. Certified shop and installation drawings showing all details of construction, dimensions, and anchor bolt locations.
 - 3. Descriptive literature, bulletins, and catalogs of the equipment.
 - 4. The weight of each component.
 - 5. Complete description of surface preparation and shop prime painting.
- B. In the event it is not possible to conform with certain details of the Specifications, describe completely all non-conforming aspects.
- C. Furnish sets of operation and maintenance instructions as specified in Section 01002. Prepare them specifically for this installation, and include all required cuts, drawings, equipment lists, spare part lists, descriptions, and other information as required to instruct operating and maintenance personnel unfamiliar with this equipment. The maintenance instructions shall include trouble shooting data and full preventive maintenance

schedules. Include copies of all approved Shop Drawings in the Operation and Maintenance Manuals.

1.04 REFERENCE STANDARDS

- A. American Society for Testing and Materials (ASTM)
 - 1. ASTM A126 Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
 - 2. ASTM A276 - Standard Specification for Stainless and Heat-Resisting Steel Bars and Shapes
 - 3. ASTM A436 - Specification for Austenitic Gray Iron Castings
 - 4. ASTM B98 - Specification for Copper-Silicon Alloy Rod, Bar, and Shapes
 - 5. ASTM B584 - Standard Specification for Copper Alloy Sand Castings for General Applications
 - 6. ASTM A240 Standard for Stainless Steel
- B. American Water Works Association (AWWA)
 - 1. AWWA C561– Fabricated Stainless Steel Slide Gates
 - 2. AWWA C540 - Standard for Power Actuating Devices for Valves and Slide Gates
- C. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 QUALITY ASSURANCE

- A. Qualifications
 - 1. The slide or weir gates, operators, operating stems, and appurtenances shall be the standard product of a single manufacturer who is fully experienced, reputable and qualified in the manufacture of the equipment furnished. The slide or weir gates, operators, operating stems, and all related equipment shall be manufactured and installed in accordance with the best practices and methods, and shall operate satisfactorily when installed as shown on the Drawings.
 - 2. The slide or weir gates and operators shall be as manufactured by
 - a. Rodney Hunt Company, Orange, Massachusetts;
 - b. Hydro-Gate Corporation, Denver, Colorado;
 - c. WACO Products, Inc., Baltimore, Maryland;
 - d. Whipps, Inc., Athol, Massachusetts
 - e. Or Approved Equal
- B. Should equipment which differs from these Specifications be offered and determined by the Engineer to be the equal of that specified, such equipment shall be acceptable only on the basis that any revision in the

design and construction of the structure, piping, appurtenant equipment, electrical work, or any other portion of the work required to accommodate such a substitution be made at no additional cost to the Owner and be as approved by the Engineer.

- C. The manufacturer shall furnish an engineer experienced in the erection, alignment, and operation of the equipment furnished under this Section for a minimum of two trips for a minimum total time at the site of not less than three days. Each day shall include a full eight-hour working day on the project site. Travel time shall be in addition to these requirements. Qualifications of the manufacturer's engineer shall be submitted to the Engineer for approval. Manufacturer's agents shall not perform this service, unless factory authorized.
- D. The manufacturer's engineer shall be present to ensure proper erection and satisfactory operation of the equipment. He shall be present at least once during each of the following times:
 - 1. Setting of the first gates
 - 2. Inspect the final installation of the equipment and certify its readiness for operation.
- E. A factory field-service representative who has complete knowledge of the proper operation and maintenance of the equipment furnished shall be provided for one day as defined above, and in addition to the days required above, to instruct representatives of the Owner and Engineer on proper operation and maintenance of the equipment. An additional trip is not necessarily required, if the training can be satisfactorily scheduled as an extension of the installation and inspection trips, as provided under Part 3 and provided that the final operational test is successful, and provided that the Operation and Maintenance Manuals instructions have been furnished and approved.

1.06 SYSTEM DESCRIPTION

- A. The equipment covered by these Specifications is intended to be standard slide or weir gate equipment, as modified by these Specifications, to control water flow. Slide or weir gates shall be of fabricated 316 stainless steel, and shall conform to the dimensions and characteristics as specified and as indicated on Drawings.

1.07 TOOLS AND SPARE PARTS

Special tools and spare parts required for normal operation and maintenance of the equipment shall be furnished in accordance with Section 01600.

PART 2 - PRODUCTS

2.01 SLIDE OR WEIR GATES

- A. Slide or weir gates shall conform to the standard specifications for slide or weir gates, AWWA C561, except as otherwise specified herein.
- B. The gates shall be non-self-contained or self-contained frame, rising stem, and shall have adequate strength to prevent distortion in handling and placing and under any condition of service outlined herein. Gates shall open upward or downward (weir type) as shown on the Drawings. All mating and sliding surfaces shall be fully machined where required. Bottom sealing shall be with a resilient, flush bottom seal. Slide or weir gates shall be completely shop assembled, factory hydrostatically tested and adjusted to pass the leakage requirements specified herein. Gates shall be designed for the seating and unseating heads specified herein. Maximum allowable leakage shall be 0.05 gallons per minute per wetted foot perimeter for seating and 0.05 gallons per minute per wetted foot perimeter for unseating head conditions.
- C. Slide or weir gate frames, guides, and discs shall be of ASTM A-240 type 316L stainless steel. Frames and discs shall be designed with a safety factor of not less than 5 based upon the ultimate strength of the material.
- D. Frames shall be of the materials specified herein, flat back flange type construction in either self-contained (SC) or non-self-contained (NSC) arrangements as best suited to meet the specifications and/or plans. All contact surfaces of the frame shall be machined where required. The frame shall be machined to bolt to a wall. Stainless gates to employ flush bottom type frame.

Stainless gate frames shall retain the one-piece UHMW-PE seat/seals and shall not require any portion of the frame to be removed or unbolted in order to replace the seat/seals. The one-piece UHMW seat/seals shall effect dual sealing points and utilize a neoprene or nitrile compression rubber compression cord to provide self-adjusting and continuous pressure on the gate disc to meet the allowable leakage specifications herein, reduce friction and operator effort, and prevent metal-to-metal contact. Neither flat-face UHMW seat/seals nor any type of rubber seal in direct contact with the disc shall be allowed.

- E. The disc shall be 316L stainless steel one-piece construction, 1/4" minimum thickness for all members, rectangular with welded vertical and horizontal ribs. A reinforcing rib along each side shall be provided to ensure rigidity. The disc shall be manufactured so that deflection of the top and bottom ribs with full head on the gate will not allow leakage to exceed the limits

specified herein.

316 stainless steel gates shall have self-adjusting UHMW seat/seal system shall be capable of meeting the leakage requirements herein without the use of wedges or other field adjustment devices.

- F. Gate guides shall be designed to withstand the total thrust due to the water pressure. The NSC frame guides shall be of such length as to retain and support at least 2/3 the disc in the full open position and shall have a pedestal of the same material and alloy as the gate to support the operator. The yoke (bench) on SC frames shall be of heavy duty design, constructed of 316 stainless steel, and shall be attached to the guide frame to support the operator. Yokes which directly support an operator shall support the operator input shaft centerline at 36-in. above the floor.
- G. The gates shall be designed for unseating and seating head conditions.
- H. Flush bottom closures shall utilize a compressible resilient seal attached to the bottom of the frame invert with a Type 316 stainless steel bar or stainless steel fasteners. The seal shall be a specially molded shape designed to fit a pocket in the frame invert that supports the seal against the closing pressure of the disc and maintains a flush bottom construction such that the controlled waterway is level with the top of the invert seal.
- I. All fasteners for the gate and seal components shall be of 316 stainless steel, ASTM A276, Type 316.
- J. The stem shall be of ASTM A276 Type 316 stainless steel for the entire length, the metal having a tensile strength of not less than 60,000 psi. The stem shall have sufficient diameter at the base of the thread to lift the weight of the gate, offset the resistance of the gate to the maximum unbalanced head, and fully allow for starting impact. The stem shall transmit in compression at least 2.5 times the rated output of the operator floor stand with a 40 lb effort on the operator, for manually operated gates. The threaded portion of the stem shall have machine cut or machine rolled, double lead threads of the Acme type. Threads shall have a maximum surface roughness of 16 micro-inch. Stems of more than one section shall be joined by Type 316 stainless steel or low silicon bronze couplings pinned and bolted or threaded and keyed to the stems. All threaded and keyed couplings of the same size shall be interchangeable. The gates shall be provided with adjustable low zinc bronze stop collars on the stem to prevent overclosing or overopening of the gate.
- K. Stem guides shall be provided as recommended by the manufacturer. Stem guides and mounting brackets shall be of the same material as the gate frame, with low zinc silicon bronze bushings. The guides shall be split type, adjustable in two directions, and spaced at sufficient intervals to

adequately support the stem. This spacing shall not exceed an L/r ratio of 200 with the stem analyzed as a column. All bolts and nuts shall be of Type 316 stainless steel.

- L. Wherever the gate stem penetrates a concrete slab other than for connection to the operator through a pedestal (stand), furnish a Type 316L stainless steel sleeve to set in the forms to form the slab penetration. Sleeve diameter shall be as required for the stem and to allow for misalignment. Furnish a top flange with tapped holes for attachment of a rubber collar stem seal. Stem collars shall be of neoprene and shall fit against the stem threads to restrict air movement through the stem slab penetration. Hold-down for the collar shall be a Type 316 stainless steel split ring bolted to the top flange of the sleeve with Type 316 stainless steel bolts.

2.02 MANUAL OPERATORS

- A. Manual operators shall be provided for slide gates by gate manufacturer. Manual operators shall be mounted on yokes for SC gates and floor stands (pedestals) for NSC gates which shall be supported on the concrete structure, as shown on the Drawings.
 - 1. Floor stands (pedestals), where applicable, shall be fabricated 316 stainless steel construction of the same alloy as the gate. The pedestal height shall be such that the handwheel or gearbox input shaft centerline will be approximately 36-in above the operating floor. Floor stands shall be attached to the concrete with Type 316 stainless steel anchor bolts, which shall be wedge type or epoxy type as specified by the manufacturer, or embedded into the concrete. Anchorage shall have a factor of safety of 2 times the rated output of the operator with 40 pounds effort on the operator when closing the gate. Drilled-in anchors will not be acceptable.
 - 2. Operators shall have gear reduction as required to provide a maximum 40 pound effort to operate the gate under maximum loading, depending upon the lifting capacity required. Each type shall be provided with a threaded cast bronze lift nut to engage the operating stem. Bearings shall be provided above and below a flange on the operating nut to support both opening and closing thrusts. Operators shall require a maximum effort of 40 lbs under the specified operating conditions. Gears shall be of steel either beveled helical or spur gear type with machined cut teeth designed for smooth operation. The pinion shafts on operator floorstands, either single or double ratio, shall be 316 stainless steel and supported on tapered roller or needle anti-friction type bearings as required, and enclosed in a cast iron case and cover. Positive mechanical seals shall be provided on the operating nut and the

pinion shafts to exclude moisture and dirt and prevent leakage of lubricant out of the hoist. Lubricating fittings shall be provided for the lubrication of all gears and bearings. Operators shall be designed to withstand operating forces generated by applying an 80 pound effort on the operator in either an opening or closing direction.

3. The handwheel shall be heavy duty cast aluminum. Operators shall be equipped with fracture resistant clear butyrate or polycarbonate plastic stem covers which shall not discolor or become opaque for a minimum of 5 years after installation. The top of the stem cover shall be closed. The bottom end of the stem cover shall be mounted in a housing or adapter plate for easy field mounting. Stem covers shall be complete with indicator markings to indicate gate position. An arrow with the word "OPEN" shall be permanently attached or cast onto the operator to indicate the direction of rotation to open the gate.

2.03 SURFACE PREPARATION AND SHOP PAINTING

- A. 316 stainless steel, and non-ferrous surfaces of the gates shall not require coatings. All cast iron and fabricated steel surfaces of operators and operator supports shall be prepared and shop primed as part of the work of this Section. Surface preparation and shop painting shall be as specified in Section 090000.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Installation of all gates and appurtenances shall be done by the Contractor in a workmanlike manner. It shall be the responsibility of the Contractor to handle, store and install the equipment specified in this Section in strict accordance with the manufacturer's drawings and recommendations. Frames shall be installed in a true vertical plane and shall be installed with 90 degree corners.

3.02 FIELD PAINTING

- A. Field painting is included under Section 090000. The shop primer shall be compatible with the finished paint.

3.03 INSPECTION AND TESTING

- A. The Contractor shall furnish the services of a factory representative as

specified in Part 1, to inspect the final installation and supervise a test of the equipment. If there are difficulties in operation of the equipment because of the manufacturer's fabrication or Contractor's installation, additional service shall be provided at no cost to the Owner.

- B. After installation, all slide gates shall be field tested to ensure that all items of equipment are in compliance with the Specifications, including the leakage requirements.
- C. In the event that any unit fails to meet the above requirements, the necessary changes shall be made and the unit retested. If the unit remains unable to meet the test requirements to the satisfaction of the Engineer, it shall be removed and replaced with a satisfactory unit at no cost to the Owner.
- D. The manufacturer shall certify in writing that the slide gates, thimbles, and operators have been properly installed and are operating correctly.

END OF SECTION 400559

SECTION 400562

VALVES

PART 1 - GENERAL

1.01 SCOPE OF WORK:

- A. Furnish all labor, materials, equipment and incidentals required and install complete and ready for operation all valves and appurtenances as shown on the Drawings and as specified herein.
- B. All valves complete with automatic operator as required shall be furnished by a single manufacturer and shall be coordinated with instrumentation and controls furnished under Division 400000.
- C. The equipment shall include, but not be limited to, the following:
 - 1. Valve operators (including floor boxes)
 - 2. Gate valves
 - 3. Ball valves for P.V.C. pipe
 - 4. Ball valves
 - 5. Check valves
 - 6. Automatic Control Check Valve
 - 7. Butterfly valves
 - 8. Knife Gate Valve
 - 9. Diaphragm valves
 - 10. Plug valves
 - 11. Needle valves
 - 12. Stem Guides
 - 13. Air release valves
 - 14. Air Inlet Valves
 - 15. Pressure reducing valves
 - 16. Surge Relief Valve
 - 17. Air Pressure Regulation Station
 - 18. Solenoid valves
 - 19. Valve boxes
 - 20. Corporation cocks
 - 21. Expansion joints
 - 22. Flanged adapters
 - 23. Flexible couplings
 - 24. Flexible connectors
 - 25. Strainers
 - 26. Rotameter
 - 27. Diaphragm seals
 - 28. Pressure switches

29. Unions
30. Hose bibs
31. Pressure Gauges
32. Mud Valves
33. Telescoping Valves
34. Floor Type Pressure Relief Valve
35. Pipe Sleeve Seals
36. Backflow Preventer
37. Pressure Sensors

1.02 RELATED WORK:

- A. Yard piping and valves are included in Division 331100.
- B. Pipe Hangers and supports are included in Section 400507.
- C. Instrumentation and Electrical, not specified herein, are included in Divisions 260000.
- D. Valve tags are included in Division 400000.
- E. Field painting is included in Section 090000.
- F. Slide Gates are included in Division 400000.
- G. Certain appurtenances for individual types of pipe or systems are specified with the specific type of pipe or system. However, additional items are specified in this Section.
- H. Certain items similar to those specified in this Section may be specified to be furnished and installed with the individual equipment or systems. In case of conflict, those individual equipment or system requirements shall govern.
- I. Electric valve operators of all types, rate of flow controllers (including modulating valves and operators) and other types of valves, which are part of the automated instrumentation (such as some solenoid valves) if not included herein are included in Division 13. Valve operators shall, however, be mounted at the factory on the valves as specified herein, as part of the Work of this Section.
- J. Buried valves and appurtenances are included in Division 400000.

1.03 SUBMITTALS:

A. Submit materials required to establish compliance with these Specifications in accordance with Section 01002. Submittals shall include the following:

1. Certified drawing showing all important details of construction and dimensions.
2. Descriptive literature, bulletins and/or catalogs of the equipment.
3. The total weight of each item.
4. A complete bill of materials.
5. Additional submittal data, where noted, with individual pieces of equipment.

B. Test Reports

Provide certified hydrostatic test data, per manufacturer's standard procedure or MSS-SP-61 for all valves.

C. Certificates

For each valve specified to be manufactured, tested and/or installed in accordance with AWWA and other standards, submit an affidavit of compliance with the appropriate standards, including certified results of required tests and certification of proper installation.

D. Manufacturer's Installation and Application Data

E. Operating and Maintenance Data

Operating and maintenance instructions shall be furnished to the Engineer as provided in Section 01002. The instructions shall be prepared specifically for this installation and shall include all required cuts, drawings, equipment lists, descriptions and other information required to instruct operating and maintenance personnel unfamiliar with such equipment.

1.04 REFERENCE STANDARDS:

A. American Society for Testing and Materials (ASTM)

1. ASTM A48 Standard Specification for Gray Iron Castings.
2. ASTM A126 Standard Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings.
3. ASTM A15 Standard Specification for Automotive Gray Iron Castings.
4. ASTM A240 Standard Specification for Heat-Resisting

Chromium and Chromium-Nickel Stainless Steel Plate, Sheet and Strip for Pressure Vessels.

5. ASTM A276 Standard Specification for Stainless and Heat-Resisting Steel Bars and Shapes.
6. ASTM A436 Standard Specification for Austenitic Gray Iron Castings.
7. ASTM A536 Standard Specification for Ductile Iron Castings.
8. ASTM B30 Standard Specification for Copper-Base Alloys in Ingot Form.
9. ASTM B62 Standard Specification for Composition Bronze or Ounce Metal Castings

B. American Water Works Association (AWWA)

1. AWWA C111 Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
2. AWWA C500 Metal-Seated Gate Valves Supply Service.
3. AWWA C504 Rubber-Seated Butterfly Valves.
4. AWWA C507 Ball Valves, 6-in Through 48-inch (150mm Through 1200mm).
5. AWWA C508 Swing-Check Valves for Waterworks Service, 2-inch (50mm Through 24-inch 600mm) NPS
6. AWWA C509 Resilient-Seated Gate Valves for Water and Supply Service
7. AWWA C511 Reduced-Pressure Principle Backflow-Prevention Assembly
8. AWWA C540 Power-Actuating Devices for Valves and Sluice Gates
9. AWWA C550 Protective Epoxy Interior Coatings for Valves and Hydrants
10. AWWA C800 Underground Service Line Valves and Fittings.

C. American National Standards Institute (ANSI)

1. ANSI B2.1 Specifications, Dimensions, Gauging for Taper and Straight Pipe Threads (except dry seals).
2. ANSI B16.1 Cast Iron Pipe Flanges and Flanged Fittings
3. ANSI B16.10 Face-to-Face and End-to-End Dimensions of Valves
4. ANSI B16.104 Butterfly Valves

D. American Iron and Steel Institute (AISI)

E. Manufacturer's Standardization Society of the Valve and Fittings Industry (MSS)

1. MSS-SP-61 Pressure Testing of Steel Valves.
2. MSS-SP-67 Butterfly Valves.
3. MSS-SP-70 Cast Iron Gate Valves, Flanged and Threaded

- 4. MSS-SP-71 Ends.
Cast Iron Swing Check Valves, Flanges and Threaded Ends.
- 5. MSS-SP-72 Ball Valves with Flanged or Butt-Welding Ends for General Services.
- 6. MSS-SP-78 Cast Iron Plug Valves, Flanged and Threaded Ends.
- 7. MSS-SP-80 Bronze Gate, Globe, Angle and Check Valves.
- 8. MSS-SP-82 Valve Pressure Testing Methods.
- 9. MSS-SP-98 Protective Epoxy Coatings for the Interior of Valves and Hydrants.

F. National Electrical Manufacturers Association (NEMA)

G. Underwriters Laboratories (UL)

H. Factory Mutual (FM)

I. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 QUALITY ASSURANCE:

A. Qualifications

1. Valves and appurtenances shall be products of well established firms who are fully experienced, minimum five (5) years, reputable and qualified in the manufacture of the particular equipment to be furnished.
2. The equipment shall be designed, constructed and installed in accordance with the best practices and methods and shall comply with these Specifications as applicable.
3. All units of the same type shall be the product of one manufacturer.

B. Certifications

1. The manufacturers shall furnish an affidavit of compliance with Standards referred to herein as specified in Paragraph 1.03C. Refer to PART 3 for testing required for certain items in addition to that required by referenced standards.

C. Provide the services of a qualified and factory-trained service representative of the manufacturer to provide operational and maintenance instruction, for a one-day, eight hour period for:

1. Valve motor operators.
2. Pressure regulating valves.
3. Air release, air and vacuum valves.

4. Surge relief valves.
5. Cone valves.
6. Dashpot-style check valves.

D. Inspection of the units may also be made by the Engineer or other representative of the Owner after delivery. The equipment shall be subject to rejection at any due to failure to meet any of the Specification requirements, even though submittal data may have been accepted previously. Equipment rejected after delivery shall be marked for identification and shall be removed from the job site at once.

1.06 SYSTEM DESCRIPTION:

- A. All of the equipment and materials specified herein are intended to be standard for use in controlling the flow of wastewater, sludges, air and chemicals, raw, filtered and finished water as noted on the Drawings.
- B. Valves, appurtenances and miscellaneous items shall be installed as shown on the Drawings and as specified, so as to form complete workable systems.
- C. Unless otherwise noted all powered valve operators shall have:
 1. Valves larger than 3 inches:
 - a. electric operators 460 volt, 3 phase, 60 hz.
 2. Solenoid valves:
 - a. 110 volt, single phase, 60 hz, NEMA 4 enclosure, continuous duty Class F coils and manual operator.
 3. See other paragraphs for additional requirements.

1.07 DELIVERY, STORAGE AND HANDLING:

- A. Reference is made to Section 01002 for additional information.
- B. Packing and Shipping
 1. Care shall be taken in loading, transporting and unloading to prevent injury to the valves, appurtenances, or coatings. Equipment shall not be dropped. All valves and appurtenances shall be examined before installation and no piece shall be installed which is found to be defective. Any damage to the coatings shall be repaired as acceptable to the Engineer.
 2. Prior to shipping, the ends of all valves shall be acceptably covered to prevent entry of foreign material. Covers shall remain in place until after installation and connecting piping is completed.
 - a. All valves 3 inches and larger shall be shipped and stored on site until time of use with wood or plywood covers on each valve end.

- b. Valves smaller than 3 inches shall be shipped and stored as above except that heavy cardboard covers may be used on the openings.
- c. Rising stems and exposed stem valves shall be coated with a protective oil film which shall be maintained until the valve is installed and put into use.
- d. Any corrosion in evidence at the time of acceptance by the Owner shall be removed, or the valve shall be removed and replaced.

C. Storage and Protection

- 1. Special care shall be taken to prevent plastic and similar brittle items from being directly exposed to the sun, or exposed to extremes in temperature, to prevent deformation. See the individual piping specifications and manufacturer's information for further requirements.

1.08 MAINTENANCE:

- A. Special tools and the manufacturer's standard spare parts, if required for normal operation and maintenance, shall be supplied with the equipment where noted and as specified herein.
- B. Provide all special tools required for normal maintenance. Tools shall be packaged in a steel case, clearly and indelibly marked on the exterior to indicate equipment for which tools are intended.
- C. Provide to the Owner a list of all spare and replacement parts with individual prices and location where they are available. Prices shall remain in effect for a period of not less than one year after start-up and final acceptance.

PART 2 - PRODUCTS

2.01 GENERAL:

- A. All valves and appurtenances shall be of the size shown on the drawings and shall be from one manufacturer.
- B. All valves and appurtenances shall have the name of the maker and the working pressure for which they are designed cast in raised letters upon some appropriate part of the body.

2.02 GATE VALVES:

- A. Gate valves unless otherwise specified or approved, shall be ductile iron body, bronze mounted, resilient wedge gate valves with flanged ends and rated for 250 psig cold water pressure conforming to the AWWA Standard for Gate Valves for Ordinary Water Works Service, Designation C515, insofar as applicable.
- B. Exposed valves shall be outside screw and yoke type and buried valve shall be non-rising stem with 2-inch square cast iron wrench nuts.
- C. Face to face dimension shall conform to ANSI Standard Face to Face and End to End Dimensions of Ferrous Valves, (ANSI 816.10) for 125 pound cast-iron valves.
- D. Handwheels or chain wheels shall be turned counterclockwise to open the valves. Handwheels shall be of ample size and shall have an arrow and the word OPEN cast thereon to indicate the direction of opening.
- E. Stuffing box follower bolts shall be of steel and the nuts shall be of bronze.
- F. The design of the valves shall be such as to permit packing the valves without undue leakage while they are wide open and in service. O-ring stuffing boxes may be used.
- G. Valves 16 inches or larger shall be provided with bevel or spur gears depending on the position of the main valve as indicated on the Drawings. The gear cases shall be of the extended type to permit repacking the stuffing box of the valve without disassembly. Valves 16 inches or larger designed to lie horizontally shall be equipped with rollers or shoes to carry the weight of the wedge throughout its travel.
- H. Where indicated on the Drawings or necessary due to location, size, or inaccessibility, chain wheel operators shall be furnished with the valves. Such operators shall be designed with adequate strength for the valves with which they are supplied and to provide for easy operation of the valve. Chains for valve operators shall be galvanized.
- A. Where required gate valves shall be provided with a box cast in the slab and a box cover. Length of box shall be slab thickness. Box cover opening shall be for valve stem and nut. Valve wrenches and the valves. The floor box and cover shall be equal to those manufactured by American Flow Control Series 2500, Clow, or approved equal.

2.03 BALL VALVES FOR PVC PIPE:

- A. Ball valves for PVC pipe shall be of PVC Type 1 with union, socket,

threaded or flanged ends as required. Ball valves shall be full port, full flow, all plastic construction, 150 psi rated with eflon seat seals, O-ring and T-handles. Valves shall be double (true) union type. PVC ball valves shall be as manufactured by Celanese Piping Systems, Inc., Wallace and Tiernan Inc., Plastiline, Inc., or approved equal.

- B. All valves shall be mounted in such a position that valve position indicators are plainly visible when standing on the floor.

2.04 BALL VALVES (3 inches and smaller):

- A. Ball valves 3 inches and smaller shall be bronze, or carbon steel body; full bore, fire safe, rated for pressure of 250 psi. Valve ends shall be flanged, threaded, or soldered as required. All valves furnished shall be by the same manufacturers.
- B. The design of the valve shall provide suitable seating in both directions. To compensate for wear on the seating surfaces, the valve shall utilize a separate ball and stem design which will allow the ball to float freely under pressure against the downstream seat and seal tightly under all service conditions. The stem shall be designed to prevent blowout. Ball valves shall have Type 316 stainless steel balls and trim, RTFE seats and RTFE stem packing.
- C. The valves shall not require lubrication but shall have stuffing boxes which can be packed with the valve in service without undue leakage.
- D. Valves shall be furnished with lever actuator attached to each valve.
- E. Valves shall be "Apollo" series as manufactured by Conbraco Industries, Inc. or approved equal.

2.05 CHECK VALVES:

- A. Swing check Valve with Air Cushion Cylinder shall be constructed of heavy ductile iron body with a stainless steel body seat ring and single continuous stainless steel shaft for attachment of outside weight and lever and a **totally enclosed** air cushion cylinder. Cushion Chambers will not be accepted.
- B. The valve shall prevent the return of water or sewage back through the valve on pump shut off or power failure and be tight seating. The seat ring must be renewable and securely held in place by stainless steel screws.
- C. The cushion cylinder assembly shall be externally attached to the side of the valve body. The cylinder piston rod is connected to the external lever arm in a manner to lift the piston upwards when flow starts and downwards when the

flow stops to compress the entrapped air in the cylinder for cushion closing. The cushion cylinder shall be fitted with an adjustable control valve to increase or decrease air compression in the cylinder.

- D. The valve disc shall be ductile iron suspended from a stainless steel shaft which shall pass through a stuffing box and be connected to the cushion cylinder on the outside of the valve.
- E. This valve shall be guaranteed for a period of one year against failure to operate due to faulty workmanship or defective material. The valve shall be APCO Series 250 Swing Check Valve with Air Cushion cylinder with ANSI 125/150# class flanges (rated for 250 PSI, flat faced standard), as supplied by Valve & Primer Corp., Schaumburg, Illinois, U.S.A. or approved equal.
- F. The valve shall have Stainless steel trim and cover bolts.
- G. The valve shall have standard fusion bond epoxy lined (12 mils minimum) and coated (8 mils minimum).
- H. Valve meets or exceeds AWWA C-508.
- I. Valves shall be manufactured by DeZurik/APCO, GA Industries, or Engineer approved equal.

2.06 AUTOMATIC CONTROL CHECK VALVES (ACCV):

- A. The ACCV shall have an electric motor operator for normal opening and closing operation. When the ACCV is operating as a pump control valve, it shall allow the pump to come on line against a closed control valve, which will then be allowed to open slowly so as to eliminate system surge pressure at pump start. The valve shall be capable of closing against the running pump and then be able to signal the pump controls to turn off the pump motor. This feature will eliminate or minimize water hammer or pressure surge at pump shut down. The ACCV shall be capable of modulation service if equipped with an optional 4 to 20ma. control circuit feature.
- B. The ACCV Pump Control Valve shall have a single “offset” pivoted disc above the centerline of the valve. This partially balanced design shall be capable of closing with minimal backflow and provide bubble tight shut-off. The valve shall have a non-slam closure feature without the need for any auxiliary power source supply, solenoid valves, or (oil, water or air) accumulator system. The offset pivot disc shall require minimal seating and unseating torques to prevent seat wear. The disc seat ring shall be bolted onto the disc, not welded, for ease of replacement in the field.

- C. The ACCV shall be equipped with an electric motor driven power opening feature with a gear arrangement to provide for opening the valve against the down stream pressure to drain the line when desired.
- D. The ACCV shall have a full flow area, designed to operate as a positive shut-off, throttling and/or check valve. The ACCV shall be controlled through a lost motion type of gear arrangement that is mounted on the side of the valve, totally enclosed in a lubricated gearbox. When operating as a check or throttling valve, the opening and closing speeds shall be controlled hydraulically by means of an oil dashpot system with speed control valves. This system shall be connected to the lost motion gear system and provide an independent adjustment of the opening and closing speeds.
- E. The ACCV must be fail-safe during any electrical power failure, and the disc shall close hydraulically, energized only by the flow reversal in the line. The time of this disc closure shall be adjustable from 3 seconds to 45 seconds, by means of a cam operated (dump type) timing valve, permitting instant first stage closure to any degree, and then the hydraulic dashpot allows the second and third stage control towards final closure.
- F. The ACCV body shall be of two (2) piece design, bolted together in a manner to capture the seat and be of an enlarged globe style through the disc section to create a 100% flow area to minimize head loss. The body shall have a built-in stop to positively prevent the disc from over-traveling the shutoff position. The body seat and disc ring must be hand replaceable in the field without the need for special tools, machining, or the need for removing the complete valve from the line. The seat material shall be precision molded Buna-N, reinforced with a heavy steel insert collar.
- G. The valve shaft shall be of one-piece Type 17-4PH stainless steel material and extend completely through the valve disc and into the gearbox. (Not stub shafts)
- H. Valve exterior shall be painted with a high build, corrosion resistant, alkyd resin primer, which is suitable for use in USDA, inspected facilities.
- I. A computerized valve cavitation analysis will be required upon the engineer's request.
- J. Valve shall be manufactured by APCO, "Series 8000," Adams Valves or engineer approved equal.

2.07 BUTTERFLY VALVES:

- B. Butterfly valves and operators shall conform to the AWWA Standard for Rubber Seated Butterfly Valves, Designation C504, except as hereinafter specified. Valves, except as specified hereinafter, shall be Class 150B and manufactured by DeZurik, or Henry Pratt Company; or engineer approved equal. The valve discs shall be cast iron per ASTM A48 Class 40C or Ductile Iron per ASTM A536. The disc seating edge shall be solid 316 stainless steel. The disc shall be securely attached to the valve shaft utilizing a field removable/replaceable 316 stainless steel torque screw or a tangential pin locked in place with a set screw.

- B. Valves shall have integrally cast mechanical joint ends or flanged ends. The face to face dimensions of flanged end valves shall be in accordance with Table 3 of above mentioned AWWA Standard for short-body valve. Adequate two-way thrust bearings shall be provided. Flange drilling shall be in accordance with ANSI B16.1.

- B. Valve seats shall be a natural rubber or synthetic rubber compound. Valve seats 24 inches and larger shall be of Buna-N for water, or as required for other services, and shall be retained within a dovetail groove in the valve body and locked in place by an epoxy compound edge. Compression between the seat and disc edge shall be adjustable from both the upstream and downstream side of the valve disc and the seat shall be field replaceable without disassembly of the disc and shaft. Seats with unidirectional adjustment, seats retained in the valve body by the use of fasteners and/or retaining rings, and seats retained on the valve disc are not acceptable.

- D. The valve body shall be constructed of close grain cast iron per ASTM A126, Class B with integrally cast hubs for shaft bearing housings of the through boss-type. Permanently self-lubricating corrosion resistant sleeve type bearings shall be provided and shall be sized to withstand bearing loads. Bearing loads shall not exceed 1/5 of the compressive strength of the bearing or shaft material and shall not exceed 2,500 psi. Valve shaft seals shall be self-compensating V-type packing with a minimum of four sealing rings. One-piece molded shaft seals and o-ring shaft seals are not acceptable.

- E. The valve shaft shall be turned, ground and polished constructed of 18-8 stainless steel and designed for both torsional and shearing stresses when the valve is operated under its greatest dynamic or seating torque. Shaft shall be of either a one piece unit extending full size through the valve disc and valve bearing or it may be of a stub shaft design.

- F. In general, the butterfly valve operators shall conform to the requirements of Section 3.8 of the AWWA Standard for Rubber Seated Butterfly Valves, Designation C504, insofar as applicable and as herein specified.
- G. Gearing for the operators where required shall be totally enclosed in a gear case in accordance with Paragraph 3.8.3 of the above mentioned AWWA Standard.
- H. The manual operators shall conform to Section 3.8.1 of the above mentioned AWWA Standard, insofar as applicable and handwheels shall turn clockwise to close the valves. Operators shall have indicators to show position of the valve disc. Operators shall be rigidly attached to the valve body or to its floor stand. Where operators are to be more than 6 feet above the operating floor chain wheels and operating chains shall be furnished.
- B. Where indicated on the Drawings extension stems, floor stands, couplings, stem guides and floor boxes as required shall be furnished and installed. Double flange fabricated steel wall thimbles shall be provided for all rectangular butterfly valves.

2.08 KNIFE GATE VALVES (SSTL):

- A. Valves shall be bonnetless knife gate
- B. Valve face-to-face dimension shall meet TAPPI standard TIS 405-8 and MSS SP-81 for knife gate valves.
- C. Cold Working Pressure valve rating shall be 150 psi (1030 kPa) per MSS SP-81 Specification. Flange drilling shall be in accordance with ANSI B16.5 class 150.
- D. Valve body shall be a one piece casting of type (304 stainless steel for corrosive applications. Valve body shall incorporate cast in guides and jams rated to full reverse pressure. Valve inside port diameter shall be equal to ANSI B36.10 STD pipe inside diameter for both metal and resilient seated valves.
- E. Valve shall be resilient seated. Resilient seated valves shall have a stainless steel seat ring with a molded-in resilient insert bonded to the seat and gate side for installations where drip-tight shutoff is required. Resilient seat material shall be suitable for use with _raw sewage.

- F. The packing system shall fit a machined packing chamber. The packing system shall consist of multiple layers of packing. The selected packing system shall be for wet service. The packing gland shall be 316 stainless steel
- G. The fasteners shall be 316 stainless steel.
- H. The gate edge shall be radiused and have a 45 degree beveled knife edge. The gate shall be finish ground. The stem shall be type 304 stainless steel.
- I. Valves shall be model KGC by DeZurik, Red Valve or Engineer approved equal.

2.09 DIAPHRAGM VALVES (PVC):

- B. Diaphragm valves shall be constructed of PVC material with Hypalon diaphragm. Valves shall be constructed so that diaphragms can be removed without removing valves from the line. Valve ends shall be flanged or threaded. If threaded ends are offered, the valves shall be installed with at least one union connection to the PVC piping.
- B. The valves shall be Model 2406 or 2436 (screwed or flanged fittings) as manufactured by ITT Grinnell, Providence, R.I., equal by A. W. Cash Valve Mfg. Co., Decatur, Ill. Or other approved equal.

2.10 STANDARD PORT PLUG VALVES:

- A. Plug valves shall be non-lubricated eccentric type with semi-steel bodies, resilient faced plugs, and welded nickel seats in the body. Port areas shall be at least 80 percent (80%) of full pipe area for valves 20 inches and smaller. Port area shall be 70 percent (70%) for all valves 24 inches and larger. All valves 4 inches and larger shall be of the bolted design. All exposed nuts, bolts, springs, and washers shall be hot dipped galvanized, except exposed hardware for submerged valves shall be of stainless steel. Valve bodies shall be semi-steel with 125-pound ANSI Standard flanged ends for interior or above ground service, mechanical joint for buried service, or for use with threaded cast iron or ductile iron piping shall have screwed end connections. The plug shall be one piece and of sufficient design so as not to require a stiffening member opposite the face plug.

- B. Valves shall be of the non-lubricated eccentric type with resilient faced plugs and shall be furnished with end connections as shown on the plans. Flanged valves shall be faced and drilled to the ANSI 125/150 lb. standard. Mechanical joint ends shall be to the AWWA Standard C111, grooved ends per AWWA C-606. Screwed ends shall be the NPT standard.
- C. Bodies shall be of ASTM A126 Class B cast iron. Bodies in 4" (100mm) and larger valves shall be furnished with a 1/8" (3mm) welded overlay seat of not less than 90% pure nickel. Seat area shall be raised, with raised surface completely covered with weld to insure that the plug face contacts only nickel. Screwed-in seats shall not be acceptable.
- D. Plugs shall be of ASTM A126 Class B cast iron. The plug shall have a cylindrical seating surface eccentrically offset from the center of the plug shaft. The interference between the plug face and body seat, with the plug in the closed position, shall be externally adjustable in the field with the valve in the line under pressure. Plug shall be Chloroprene (CR) or resilient facing suitable for application.
- E. Bearing shall have sleeve type metal bearings and shall be of sintered, oil impregnated permanently lubricated type 316 ASTM A743 Grade CF8M in ½ -36" (15-900mm) sizes. In valves larger than 36" (900mm), the upper and lower plug journals shall be fitted with ASTM A-240 type 316 stainless sleeves with bearings of ASTM B30, Alloy C95400 aluminum bronze. Non-metallic bearings shall not be acceptable.
- F. Shaft seals shall be of the multiple V-ring type and shall be externally adjustable and repackable without removing the actuator or bonnet from the valve under pressure. Valves utilizing O-ring seals or non-adjustable packing shall not be acceptable.
- G. Pressure ratings shall be 175 psi (1210 kPa) on sizes ½ -12" (15-300mm) and 150 psi (130 kPa) for 14-72" (350-1800mm). Every valve shall be given a hydrostatic and seat test results being certified when require by the specifications.
- H. All valves 8 inches and larger shall be equipped with gear actuators. All gearing shall be enclosed suitable for running in oil with seals provided on all shafts to prevent entry of dirt and water into the actuator. All shaft bearings shall be furnished with permanently lubricated bronze bearing bushings. Actuator shall clearly indicate valve position and an adjustable stop shall be provided. Construction of actuator housing shall be semi-steel.
- I. All valves and actuators shall be as manufactured by DeZurik Corporation

(PEC series), or engineer approved equal.

2.11 100% PORT PLUG VALVES:

- A. Bodies shall be of ASTM A126 Class B cast iron. Port shall be rectangular. Port area shall be 100% of Standard class pipe area. Bearings shall be sleeve type and made of sintered, oil-impregnated permanently lubricated type 316 stainless steel per ASTM A743 Grade CF8M.
- B. Seats shall be 1/8" thick welded overlay of not less than 95% pure nickel. Seat shall be at least 1/2" wide and raised. The raised surface shall be completely covered with nickel to ensure that the resilient plug face contacts only the nickel seat.
- C. Adjustable Packing shall be of the multiple V-ring type, with a packing glad follower. Shaft seals shall permit inspection, adjustment or complete replacement of packing without disturbing any part of the valve or actuator assembly except the packing glad follower.
- D. Grit Excluders made of PTFE Shall be provided to prevent the entry of grit and solids into the bearing areas.
- E. Pressure ratings shall be bi-directional and 175 psi (1,207 kPa) on sizes 3"-12" (80-300mm) and 150 psi (1,034 kPa) for 14"-36" (350-900mm). Every valve shall be given a certified hydrostatic and seat test, with test reports being available upon request.
- F. Plug valves installed such that actuators are 6 feet or more above the floor, shall have handwheels.
- G. Where shown on the Drawings plug valves shall be installed with extended shafts and actuators. Actuators for extended shafts shall be mounted on floor stands where indicated on the Drawings or shall be removable handwheels where floor stands are not called for. Six inch sleeves shall be provided for extended shafts in all floors; where necessary covers shall be provided. Shafts shall be of adequate strength to operate the valve. Floor stands and covers, where called for shall be cast iron. Floor stands shall be equipped with valve position indicators and a lock for the handwheel. Valve boxes for buried valves shall be as Specified herein.
- H. All plug valves shall be installed so that the direction of flow through the valve is in accordance with the manufacturer's recommendations.

- I. Valve shall be manufactured by DeZurik, Val-matic or engineer approved equal.
- J. Electric Operators:
 1. In general, electric plug valve operators shall conform to the requirements as herein specified.
 2. The motor operated valve actuator shall include the motor, operator unit gearing, limit switch gearing, limit switches, torque switches, bored and key-wayed drive sleeve for nonrising stem valves, declutched lever and auxiliary handwheel as a self-contained unit.
 3. The motor shall be specifically designed for valve operator service requiring electric power as shown on the electrical Drawings. The motor shall be sized per AWWA Standards for electric motor operators and shall be totally enclosed, non-ventilated type for outdoor service. The power gearing shall consist of generated helical gears of heat treated alloy steel forming the first stage of reduction. The second reduction stage shall be a worm and worm gear. The worm shall be of alloy steel with carburized threads hardened and ground for high efficiency. The worm gear shall be of high tensile strength bronze with bobbed teeth. All power gearing shall be grease lubricated. Ball or roller bearings shall be used throughout. Preference will be given to units having a minimum number of gears and moving parts. Spur gear reduction shall be provided as required.
 4. Limit switches and gearing shall be an integral part of the valve control. The limit switch gearing shall be made of bronze and shall be grease lubricated, intermittent type and totally enclosed to prevent dirt and foreign matter from entering the gear train. Limit switches shall be of the adjustable type capable of being adjusted to trip at any point between fully opened valve and fully closed valve.
 5. The speed of the operator shall be the responsibility of the system supplier with regards to hydraulic requirements and response compatibility with other components within the control loop. Each valve actuator shall be provided with a minimum of two rotor type gear limit switches, one (1) for opening and one (1) for closing. The rotor type gear limit switch will have two (2) normally open and two (2) normally closed contacts per rotor. Gear limit switches must be geared to the driving mechanism and in step at all times whether in motor or manual operation. Provision shall be

made for two additional rotors as described above each to have two normally open and two normally closed contacts. Each valve actuator shall be equipped with a double torque switch. The torque switch shall be adjustable and will be responsive to load encountered in either direction of travel. It shall operate during the complete cycle without auxiliary relays or devices to protect the valve should excessive load be met by obstructions in either direction of travel. The torque switch shall be provided with single-pole contacts.

6. A permanently mounted handwheel shall be provided for manual operation. The handwheel shall not rotate during electric operation, but must be responsive to manual operation at all times except when being electrically operated. The motor shall not rotate during hand operation nor shall a fused motor prevent manual operation. When in manual operating position, the unit will remain in this position until motor is energized at which time the valve operator will automatically return to electric operation and shall remain in motor position until handwheel operation is desired. This movement from motor operation handwheel operation shall be accomplished by a positive declutching level which will disengage the motor and motor gearing mechanically but not electrically. Hand operation must be reasonably fast. It shall be impossible to place the unit in manual operation when the motor is running. The gear limit switches and torque switches shall be housed in a single easily accessible compartment integral with the power compartment of the valve control. All wiring shall be accessible through this compartment. Stepping motor drives will not be acceptable.
7. All units shall have strip heaters in both the motor and limit switch compartments.
8. The operator shall be equipped with open-stop-close push buttons, a local-remote selector switch and indicating lights all mounted on the operator or on a separate locally mounted power control station.
9. Motor shall be designed for operation as shown on the Drawings. Operator shall be as manufactured by Rotork, EIM, or engineer approved equal and shall be mounted on a torque tube.

2.12 NEEDLE VALVES:

- A. The needle valves shall have a cast bronze body and be constructed in accordance with ASTM B62 and shall be designed for an operating

pressure of 125 psi and a 200 psi maximum test pressure. Ends shall be ANSI B2.1 threaded. The valves shall have a rising bronze stem and non-slip malleable iron hand wheel.

- B. The needle valves shall be Figure 680 as manufactured by the Wm. Powell Company, Cincinnati, Ohio, or Figure 88 as manufactured by Crane Company, Valve Division, Chicago, Illinois, or approved equal.

2.13 STEM GUIDES:

Adjustable stem guides of the wall bracket type shall be provided as shown on the Drawings. The guide where the extension stem passes through shall be bronze bushed. Stem guide shall be Model F5660 as manufactured by Clow Corporation, Bensenville, Illinois, equal Rodney Hunt Company, Orange, Massachusetts, or approved equal.

2.14 AIR VALVES:

- A. The air release valves for use in water mains shall be installed as shown on the Drawings. The valves shall have a cast iron body, cover and baffle, stainless steel float, bronze water diffuser Buna-N or Viton seat and stainless steel trim. Valves shall be provided with a vacuum check to prevent air from reentering the line. The fittings shall be 6" Flanged and have a 1" discharge orifice on the forcemain. The air release valves shall be Model 207 as manufactured by APCO Valve and Primer Corporation, Schaumburg, Illinois; Model 45VC by Val-Matic Valve and Manufacturing Corporation, Lyons, Illinois or engineer approved equal.
- B. The Vacuum Relief/Air Inlet Valve shall have globe type body with integrally cast-on flanged ends. The valve shall have a cross-sectional inflow area 10% greater than equivalent pipe size for full vacuum relief protection during draining, pipeline rupture or water column separation. The Vacuum Relief/Air Inlet Valve will be covered by a steel hood to prevent debris entering.

The internal valve plug and seat shall be heavy cast bronze. The seat is retained in the body by a heavy cover having a (molded, not glued) resilient Buna-N seal, for positive shut-off. The plug is center guided on both ends to prevent jamming. The plug shall be normally closed, by means of a stainless spring and shall open when a vacuum/pressure differential exceeds 0.25 psi (2 kpa).

The Air Inlet Valve shall be model 1500 – Vacuum Relief / Air Inlet Valve (Flange Tpe) as manufactured by APCO Valve and Primer Corporation, Schaumburg, Illinois, or approved equal.

- C. The air release valves for use at the pump discharge shall be Slow Closing Air/Vacuum Valve shall be four valves furnished assembled and tested as a single unit. The Air/Vacuum Valve must have a stainless steel float guided at each end with stainless stems. The stems shall be guided through stainless steel bushings inside the body and cover. The seat* must be Buna-N fastened to the cover with stainless shoulder screws without distortion to allow drop tight closure.

The cover shall have a male lip to fit the female body register for positive float guide direction into the seat. Cover outlets may be threaded, flanged, or hooded. (Engineer to specify.)

The Surge Check Valve shall be a normally open spring loaded valve consisting of a body, seat and plug bolted to the inlet of the Air/Vacuum Valve. The surge check shall operate on the interphase between the kinetic energy and relative velocity flows of air and water. It will allow air to pass through but water shall actually close the surge check, reducing the rate of water flow by means of throttling orifices in the plug to prevent shock closure of the Air/Vacuum Valve. The surge check orifices must be adjustable type to suite operating conditions in the field.

The inlet Isolation Butterfly Valve shall be DeZurik BOS wafer (compact) style. lever and variable position locking device. for special tools or skill. The seat must be Buna-N, molded with a steel flanged insert for high strength and tight seating. The disc must pivot eccentrically from closed position to clear center valve area.

The Air Release Valve shall be side connected to the upper valve, but separated with an Isolation Shut-Off Valve. The internal mechanism shall be the compound lever type to permit the valve to open under pressure to vent pockets of entrapped air as they accumulate. The compound mechanism shall be activated by a stainless steel concave float to lift the Buna-N needle to shut-off the Air Release orifice.

The Slow Closing Air/Vacuum Valve shall have been flow tested in the field, substantiated by test data to show reduction of surge pressure in the valve

The Release Valve shall be model 1900 – Slow Closing Air & Vacuum Valve as manufactured by APCO Valve and Primer Corporation, Schaumburg, Illinois or GA Industries, or approved equal.

2.15 PRESSURE REDUCING VALVES:

- A. The valve shall be a Singer Valve model 106 - PR - 48, ANSI Class 150

(ANSI 300, ANSI flanges drilled to ISO PN 10 / 16/ 25 or 40) pressure rating/ flange standard, globe (angle), style valve. The Model 160 Pressure Reducing Pilot (Normally Open Pilot) spring range shall as specified by the Engineer.

1. The valve shall maintain accurate control of the downstream pressure regardless of fluctuation in flow or upstream pressure through main valve with the exception of low flow applications where a direct acting by-pass pressure-reducing valve will over ride the operation of the main valve.
2. Refer to "Main Valve" section, 106-PG for detailed information pertaining to valve sizes and materials, selection criteria and specifications.
3. Refer to "Pilot and Accessories" section, Model 160 Pressure Reducing Pilot (Normally Open Pilot) and Model 26 Flow Stabilizer for detailed information pertaining to materials and specifications. Consult factory for direct acting Low Flow By-Pass specification information.
4. Main Valve:
 - a. Valve(s) shall be a hydraulically operated globe (angle) valve. The inner valve assembly shall be top and bottom guided by means of easily replaceable bearing bushings. The inner valve assembly shall be the only moving part and shall be securely mounted on a 316 stainless steel stem. The stainless steel stem shall be provided with wrench flats on all valves 1" (25mm) to 16" (400mm), for ease of assembly and maintenance.
 - b. All pressure containing components shall be constructed of ASTM A536-65/45/12 ductile iron. The flanges shall be designed to ANSI Class 150 or Class 300 standards. Flange drilling to ANSI shall be standard however British, ISO and other drillings shall be available upon request.
 - c. Valve(s) shall have a protective fusion bonded epoxy coating internally and externally. The protective fusion bonded epoxy coating shall conform to the ANSI/AWWA C116/A21.16 (current version) specification.
 - d. Valve(s) 8" (200mm) and smaller shall provide smooth "frictionless" motion with actuation being achieved by the use of a SRD style EPDM diaphragm. They shall be constructed of nylon fabric bonded with synthetic rubber. The diaphragms shall not be used as a seating surface. No lip seals or packing may be used to seal the actuator.
 - e. Valve(s) 6" (150mm) and larger shall provide smooth "frictionless" motion and maximum low flow stability with actuation being achieved by the use of the Singer rolling diaphragm technology. The diaphragms shall not be used as a seating surface. No lip seals or packing may be used to seal the actuator.

- f. The valve cover shall have a separate stem cap giving access to the stem for alignment check, spring installation and ease of assembly.
- g. On valve(s) 1"(25mm) and larger, bonnets shall be accurately located to bodies utilizing locating pins. Locating pins shall eliminate corrosion resulting from the use of uncoated ductile iron to ductile iron surfaces.
- h. Valve(s) 3"(80mm) and larger shall have the 316 stainless steel seat, bolted in place, utilizing "Spiralock" thread tapping technology. The 316 stainless steel seat ring shall be easily replaceable without special tools.
- i. The valve(s) shall form a drip tight seal between the stationary stainless steel seat ring and the resilient disc, which has a rectangular cross-section and is retained by clamping on three and one half sides. The resilient disc shall be constructed of Buna or EPDM for normal service conditions.
- j. All external fasteners shall be 18-8 stainless steel with 18-8 washers.
- k. All repairs and maintenance shall be possible without removing the valve from the line. To facilitate easy removal and replacement of the inner valve assembly and to reduce unnecessary wear on the guide, the stem shall be vertical when the valve is mounted in a horizontal line.
- l. Each valve shall be tested prior to shipment. The standard test shall include a pressure test and a full functional, operational test when pilots and accessories are fitted to suit a particular application.
- m. The valve(s) shall be covered by a minimum three year (3) warranty against defects in materials and workmanship. The stainless steel seat ring shall be covered by a lifetime replacement warranty.
- n. The valve shall be manufactured by Singer Valve or approved equal.

5. Pilots & Accessories:

- a. The pilot shall be Singer Model 160, with the spring range specified.
- b. The normally open pilot shall be of bronze construction with a spring to adjust the pressure setting.
- c. The pilot seat, stem and inner valve shall be of stainless steel 316 constructions and the inner valve shall have EPDM resilient compound for seating. The EPDM compound must be bonded permanently to the inner valve and be ground flat and square to assure maximum performance.
- d. The pilot guide stem shall be guided by a Delrin bushing in the spring casing above the diaphragm and totally removed from the flow of water in the main pilot chamber. The pilot guide and stem location above the diaphragm shall eliminate debris buildup and

sticking as well as minimize turbulence and false readings on the diaphragm.

- e. The pilot shall be self-cleaning and self-flushing by locating the outlet in the bottom of the pilot ninety degrees to the inlet.
- f. Maximum Working Temperature: 180 degree F (82 degree C)
- g. Maximum Working Pressure: 400 psi (27.6 bar)

6. The flow stabilizer shall be a Singer Model 26 (sizes 8" 106, 10" 206 and smaller is included) or approved equal.

- a. The flow stabilizer body shall be of stainless steel construction.
- b. The flow stabilizer shall allow unrestricted flow into the main valve bonnet while offering adjustable restricted flow out of the bonnet.
- c. The flow stabilizer shall be self cleaning and resistant to plugging
- d. The Singer proprietary tapered internal orifice and inner valve shall offer precise adjustment, which shall be lockable by utilizing the top locknut.
- e. The flow stabilizer shall improve low flow stability when incorporated with other "Singer Low Flow" proprietary automatic control valve enhancements.
- f. Maximum Working Temperature: 180 degree F (82 degree C)
- g. Maximum Working Pressure: 400 psi (27.6 bar)
- h. Connections: ¼" (6.35 mm) NPT

2.16 AIR PRESSURE REGULATION STATION:

- A. Air receivers for the instrument air pressure regulation station shall be built to ASME standards and have a National Board certificate. One tank shall have a 100 gallon capacity, approximately 20-inch diameter x 75-inch, designed for vertical mounting. The second tank shall have a 40 gallon capacity, approximately 15 inch diameter x 54 inch, also designed for vertical mounting. Design pressure shall be 200 psig. Fittings shall include a manual ½-inch ball drain valve with fittings, inlets, outlet and all required taps for control piping. Provide a 3 ½ inch gauge with 200 psi pressure range, plus two gauge petcocks, one for the gauge and one for the inspector's test connection, and necessary fittings to install the gauge and petcocks. Provide all other fittings as shown on the drawings for pipe connections and drains. There shall also be an approved safety relief valve for each tank set for the tank working pressure plus necessary fittings to install it. The receivers shall incorporate mounting legs complying with applicable standards. Legs shall set the tank a minimum of 12 inches above the floor.

- B. Air pressure regulators shall be diaphragm controlled, relieving type, made of non-corrosive materials and be equipped with a pressure gauge on the pressure regulated outlet of the regulator. Pressure regulators shall have a field adjustable regulated pressure range of 0 to 100 psig. The size of the regulators shall be as recommended by the supplier for a maximum air flow of 10 SCFM.
- C. Filter-coalescer shall be capable of delivering clean, dry air to pneumatic equipment, sized to be installed in a one-inch line for a minimum flow of 10 SCFM. Filter shall be an Ingersoll Rand 810 series, Model No. 815 or approved equal.

2.17 SOLENOID VALVES:

- A. Solenoid valves shall be normally open or closed as required. All solenoid valves shall include a manual override operator (MO). Valves shall be of brass body construction, resilient seating, general purpose service RED-HAT type as manufactured by Automatic Switch Company (ASCO), Florham, New Jersey, or approved equal.
- B. Solenoid valves specified in subparagraph 1 above shall be suitable for operation on a 120 volt, 60 Hertz power supply unless otherwise shown on the Drawings and be provided with encapsulated, Class F insulation in a NEMA Type I enclosure with a conduit knockout.
- C. All solenoid valves shall be installed with ball type bypass valves to permit operation in a manual mode where shown on drawings.

2.18 PRECAST CONCRETE MANHOLES

- A. All buried valves shall be installed in precast concrete manholes. Valve box shall be. Manhole access covers shall have "WATER" cast into the top of all water lines, "SEWER" cast into the top for all wastewater lines and "DRAIN" cast into the top of all drain line. All valves shall have actuating nuts extended to within 6 inches of the top of the valve box adapter.
- B. All buried valves shall be supplied with a valve nameplate with suitable anchors for casting in concrete. Nameplate shall be 3 inches in diameter bronze disk with raised lettering 1/8-inch high and manufactured by Shiedow Bronze Corporation, Kingwood, W. VA; or approved equal.

2.19 CORPORATION COCKS:

Corporation cocks for connections to cast-iron, ductile iron or steel piping shall be all brass or bronze suitable for 150 psi operating pressure and similar to Mueller

Co. H-10046 or equal by Clow Corp. or approved equal, and shall be of sizes required and/or noted on the Drawings.

2.20 EXPANSION JOINTS:

A. Expansion joints shall be manufactured of molded neoprene with filled triple arches. Joints shall be reinforced with galvanized 3/8-inch split steel retaining rings placed directly against the inside of the flanged to prevent damage to the rubber surface when the bolts are tightened. Expansion joints shall be suitable for buried service or above ground service. Flanges shall be drilled to ANSI 125#. Working pressures as follows:

Size	Pressure
1"-4"	165#
5"-12"	140#
14"	85#
16"-24"	65#
26"-66"	55#

B. Maximum temperature shall be 180° F and shall be capable of a maximum 1½-inch lateral movement. Expansion joints shall be Model J-1 as manufactured by the Red Valve Company, or engineer approved equal.

2.21 FLANGED ADAPTORS:

- A. Flanged adaptors where shown on the Drawings shall be "Uni-Flange" as manufactured by Uni-Flange Corporation, Series 400.
- B. Flange shall be ductile iron designed to meet the requirements of ANSI D16. Set screw shall be AISI 4140 steel, heat treated, zinc
- C. Where shown on the Drawings adaptor shall be harnessed.

2.22 FLEXIBLE COUPLINGS:

- A. Flexible couplings shall be either the split type or the sleeve Type as shown on The Drawings.
 - 1. Split type coupling shall be used with all interior piping and with exterior piping as noted on the Drawings. The couplings shall be mechanical type for radius groove piping. The couplings shall mechanically engage and lock grooved pipe ends in a positive couple and allow for angular deflection and contraction and expansion.
 - 2. Couplings shall consist of malleable iron, ASTM Specification

A47, Grade 32510 housing clamps in two or more parts, a single chlorinated butyl composition sealing gasket with a "C" shaped cross-section and internal sealing lips projecting diagonally inward, and two or more oval track head type bolts with hexagonal heavy nuts conforming to ASTM Specification A183 and A194 to assemble the housing clamps. Bolts and nuts shall be hot dipped galvanized after fabrication.

3. Victaulic type couplings and fittings may be used in lieu of flanged joints. Pipes shall be radius grooved as specified for use with the Victaulic couplings. Flanged adapter connections at fittings, valves, and equipment shall be Victaulic Vic Flange Style 741, equal by Gustin-Bacon Group, Division of Certain-Teed Products, Kansas City, Kansas, or other approved equal.
4. Sleeve type couplings shall be used where shown on the Drawings. The couplings shall be of steel and shall be Dresser Style 38, Smith Blair Style 413, Baker Allsteel, or approved equal. The coupling shall be provided with hot dipped galvanized steel bolts and nuts unless indicated otherwise.
5. All couplings shall be furnished with the pipe stop removed.
6. Couplings shall be provided with gaskets of a composition suitable or exposure to the liquid within the pipe.
7. If the Contractor decides to use victaulic couplings in lieu of flanged joints, he shall be responsible for supplying supports for the joints.

2.23 FLEXIBLE CONNECTORS:

Flexible connectors shall be constructed of bronze hose and braid with female copper tube sweat fittings brazed on each end. Connectors shall be Style BF as manufactured by Vibration Mountings and Controls, Inc., Butler, N.Y., equal by American, Waterbury, Conn., or other approved equal.

2.24 STRAINERS:

Strainers shall be installed as shown on the Drawings and shall be of the duplex basket type. Strainers shall have bronze bodies with a removable bronze screen and stainless steel baskets.. Strainers shall be of the type such that baskets can be emptied without taking the strainer offline. Strainers shall be rated for a minimum pressure of 150 psi. Strainers shall be manufactured by Hayward or approved equal.

2.25 ROTAMETER:

Rotameters shall generally be provided by the chemical equipment supply to be installed on the drawings. The meter sight tube shall be constructed of impact resistant glass with a cast bronze body. Maximum pressure loss shall be 50 inches of water. The rotameter shall be similar to Model 10A2235A - Rotosight Catalog Number 2235597 by Fischer & Porter, Warminster, Penna. or approved equal.

2.26 DIAPHRAM SEALS:

- A. Diaphragm seals shall be installed on pressure gauge connection to all sludge, chemical and air lines where shown on the Drawings, to protect pressure switches used to monitor excessive pressures on sludge, chemical and air lines. The diaphragm shall be "thread attached" to both piping and pressure switches. Diaphragm seals shall be constructed of cadmium plated carbon steel, except for the lower housing which shall be specifically chosen according to the fluid pressure being monitored.
- B. Diaphragm seals shall have a flushing connection and #. Type SB by Mansfield and Green; No. 877 Terice; Marshalltown; or approved equal.

2.27 PRESSURE SWITCHES:

- A. Pressure switches shall be suitable for mounting with diaphragm seals and installed when shown on the Drawings. Pressure switches shall be of watertight construction, with SPDT Contacts suitable for 120 volt service and ampere capacity, with external adjustment of pressure setting.
- B. Pressure switches shall be suitable for the service intended and a pressure range as specified in the Instrument List in Section 262021.
- C. The pressure switch shall be Allen-Bradley, United Electric, Mercoid, or approved equal.

2.28 UNIONS:

Unions on ferrous pipe 2 inches in diameter and smaller shall be 150 pounds malleable iron, zinc-coated. Unions on water piping 2½ inches in diameter and larger shall be flange pattern, 125-pound class, zinc-coated. Gaskets for flanged unions shall be of the best quality fiber, plastic, or leather. Unions shall not be concealed in walls, ceilings, or partitions.

2.29 HOSE BIBBS:

Hose bibbs shall be brass, polished chromium plated, as manufactured by Chicago

Faucet Company or approved equal. Hose bibbs shall be No. 952, 3/4-inch or 1 inch with vacuum breaker as noted on the Drawings.

2.30 PRESSURE GAUGES:

- A. Each pressure gauge shall be direct mounted, polished stainless steel case with a 3½-inch diameter dial and furnished with an acrylic plastic window, ¼-inch shut-off valve, and be glycerin filled with bronze or stainless steel tube. All gauges shall be weatherproofed. The face dial shall be white finished aluminum with jet black graduations and figures. The face dial shall indicate the units of pressure being measured (e.g. feet, inches, etc.) or be dual scale. Socket material shall be bronze.
- B. Pressure gauges shall be equal to Ashcroft Model 1009, or approved equal. Ranges shall be suitable to the application and will be as approved by the Engineer.

2.31 MUD VALVES:

- A. The mud valves shall be of the non-rising stem type, with cast iron body and flanged ends. The stem, stem nut, stop collar, disc ring and seat ring shall be bronze. Bolts and nuts shall be stainless steel Type 316. Where shown on the Drawings, valves shall be equipped with Type 304 stainless steel extension stem and crank operated offset-type floor stand. The distance from the bottom face of the flange to the operator shall be as shown on the Drawings.
- B. The mud valves shall be Model A25612RB as manufactured by Troy Valve, Model 0S 5002 as manufactured by Rodney Hunt Company, Orange, Massachusetts, equal by Clow Corporation, or other approved equal.
- C. Stem guides shall be provided as required as recommended by the manufacturer to prevent damage to the valve or stem. Stem guides shall be cast iron, bronze bushed, mounted on cast iron brackets.

2.32 TELESCOPIC VALVES:

- A. Telescoping valves shall be rising stem such as manufactured by Troy Valve, Fountaine, or engineer approved equal. Each valve shall be supplied as a complete unit consisting of floorstand and electric motor operator, lift rod, bail, slip tube, companion flange with sealing gasket and mounting plate.
- B. The floorstand shall be cast iron with base flange pre-drilled for anchoring to the mounting plate. The valve shall be operated by an electric motor

operator to allow for remote operation. Electric motor operator to be , Rotork Actuators, Inc. or engineer approved equal.

- C. The connecting bail shall be 304 stainless steel. The lift rod shall be 304 stainless steel. The bail shall be fastened to the lift rod with a stainless steel jam nut. The slip tube shall be 304 stainless steel with an outside diameter of 8 inches. The top discharge end shall have two (2) "V" notches 180 degrees apart for flow control. The length of the slip tube shall be sufficient to allow full required travel of four feet with enough pipe remaining below the companion flange to provide adequate support.
- D. Each valve shall be furnished with a cast iron companion flange to match the 8 inch diameter standard ductile iron flange. Each companion flange shall be furnished with a sealing neoprene gasket to be replaced without removal of slip tube from riser pipe. Mating flange and bolt to be provided by the Contractor.
- E. Valve to be supplied with a 3/8" thick stainless steel mounting plate and bracket. Plate is to be mounted to the top of thickener wall and design to support the complete valve and any necessary maintenance. All anchor bolts are to be stainless steel.

2.33 FLOOR TYPE PRESSURE RELIEF VALVES (SSTL):

Resilient Seat in Cover. Removable Stainless Steel Grate. Integrally Cast Water Stop Valves to be Supplied in Exact Required Length Valve body, lid and grate to be cast 304 Stainless Steel Extendable with PVC pipe to any length required

Valves shall be Troy Valve Model A2550RSN 304 or 316 SS, or approved equal.

2.33 PIPE SLEEVE SEALS:

A watertight seal at all wall sleeves shall be obtained using expandable rubber seal rings as shown on the Drawings. These seal rings shall be the modular mechanical type consisting of synthetic rubber links shaped to continuously fill the annular space between the pipe and wall sleeve. Links shall be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and nut. After the seal assembly is positioned in the sleeve, tightening of the bolts shall cause the rubber sealing sleeve. The watertight seal shall be effective against a hydrostatic head of at least 40 feet. The seal shall also be constructed so as to provide electrical insulation between the pipe and wall, thus reducing chances of cathodic reaction between these two members.

2.34 BACKFLOW PREVENTERS:

Backflow preventers shall be of reduced pressure type with two (2) independently operating check valves and shall be designed to operate in a horizontal flow mode. An independent relief valve shall be located between the two (2) check valves. Preventers shall be as manufactured by Hersey Products, Inc., or approved equal.

2.35 PRESSURE SENSORS:

Pressure sensors shall be of the wafer type, designed to fit between standard pipe flanges. Sensor shall be flow through design with flexible elastomer sensing ring around the full circumference. Pressure sensing ring shall measure pressure for 360 degrees around the full inside circumference of the pipeline. Sensor shall be manufactures such that it can be interlocked with pumps. All sensors shall be Series 48 as manufactured by Red Valve Company or engineer approved equal.

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. All valves and appurtenances shall be installed in the locations shown, true to alignment and rigidly supported. Any damage to the above items shall be repaired to the satisfaction of the Engineer before they are installed.
- B. After installation, all valves and appurtenances shall be tested at least two (2) hours at the working pressure corresponding to the class of pipe, unless a different test pressure is specified. If any point proves to be defective, it shall be repaired to the satisfaction of the Engineer.
- C. Install all floor boxes, brackets, extension rods, guides, the various types of operators and appurtenances as shown on the Drawings that are in masonry floors or walls, and install concrete inserts for hangers and supports as soon as forms are erected and before concrete is poured. Before setting these items, the Contractor shall check all plans and figures which have a direct bearing on their location and he shall be responsible for the proper location of these valves and appurtenances during the construction of the structures.
- D. Pipe for use with flexible couplings shall have plain ends as specified in the respective pipe sections in Division 400000.
- E. Flanged and mechanical joints under water or exposed to weather shall be made with type 304 stainless steel bolts, nuts and washers.
- F. Prior to assembly of split couplings, the grooves as well as other parts shall be thoroughly cleaned. The ends of the pipes and outside of the gaskets shall be moderately coated with petroleum jelly, cup grease, soft soap or graphite paste, and the gasket shall be slipped over one pipe end. After the other pipe has been brought to the correct position, the gasket shall be centered properly over the pipe ends with the lips against the pipes. The housing sections then shall be placed. After the bolts have been inserted, the nuts shall be tightened until the housing sections are firmly in contact, metal-to-metal, without excessive bolt tension.
- G. Prior to the installation of sleeve-type couplings, the pipe ends shall be cleaned thoroughly for a distance of 8 inches. Soapy water may be used as a gasket lubricant. A follower and gasket, in that order, shall be slipped over each pipe to a distance of about 6 inches from the end, and the middle ring shall be placed on the already laid pipe end until it is properly centered over the joint. The other pipe end shall be inserted into the middle ring and brought to proper position in relation to the pipe already laid. The gaskets and followers shall then be pressed evenly and firmly into the middle ring flares. After the bolts have been inserted and all nuts have been made up fingertight, diametrically opposite nuts shall be

progressively and uniformly tightened all around the joint, preferably by use of a torque wrench of the appropriate size and torque for the bolts.

- H. Pressure gauges shall not be installed until after the substantial completion date unless otherwise requested by the Owner.
- I. Valve boxes with concrete bases shall be installed as shown on the Drawings. Mechanical joints shall be made in the standard manner. Valve stems shall be vertical in all cases. Place cast iron box over each stem with base bearing on compacted fill and top flush with final grade. Boxes shall have sufficient bracing to maintain alignment during backfilling. Knobs on cover shall be parallel to pipe. Remove any sand or undesirable fill from valve box.

3.02 SHOP PAINTING:

Ferrous surfaces of valves and appurtenances shall receive an exterior coating of rust-inhibitive primer as specified in Section 099113. Interior coatings shall be the manufacturer's standard except that valves on raw and potable water lines shall be coated with paints approved by both EPA and AWWA for potable water service. All pipe connection openings shall be capped after shop painting to prevent the entry of foreign matter prior to installation.

3.03 FIELD PAINTING:

All metal valves and appurtenances specified herein and exposed to view will be painted as part of the Work in Section 099113. All exposed pipe joints on pipe, valves and fittings shall be caulked 360 degrees prior to painting.

3.04 INSPECTION AND TESTING:

Completed pipe shall be subjected to hydrostatic pressure tests for four (4) hours at full working pressure. All leaks shall be repaired and lines retested as approved by the Engineer. Prior to testing, the gravity pipelines shall be supported in an approved manner to prevent movement during tests.

END OF SECTION

SECTION 14500 - SHAFTLESS SCREW CONVEYOR

PART 1 GENERAL

1.1 SCOPE

A. Description of work

1. Provide all labor, material and equipment necessary to furnish and install two (2) shaftless screw conveyors as shown on the drawings, and as specified herein.
2. Each conveyor shall consist essentially of flighting, trough, trough ends, bearings, seals, drive, inlet and discharge ports and supporting steel together with any other items required for a complete conveying system.

B. Related Work Specified Elsewhere

1. The provisions of this section are a direct extension of Division 46, and although set forth only once within the Specifications, shall apply equally to this section.
2. Motors – Division 26.
3. All appurtenances including electrical controls, wiring of motor or controls and field painting are as specified under other sections of these Specifications.
4. Refer to the following Specification sections for coordination of work:
 - a. Section - 467621 – BELT FILTER PRESS

1.2 QUALIFICATIONS

A. Manufacturer

1. It is the intention of the Specifications to cover minimum acceptable quality equipment for a complete installation.
2. The conveyor shall be designed in accordance with these specifications and shall be furnished by Keystone Conveyor Corp or approved equal.

1.3 SUBMITTALS

- A. Operating instructions, manuals and shop drawings shall be submitted in accordance with the technical specifications herein.

1.4 EQUIPMENT MANUFACTURER'S SERVICE REPRESENTATIVE

- A. General. See manufacturers' requirements and details for the Manufacturers' Service Representative.
- B. Provide for equipment start-up assistance for the equipment supplied. Provide for one (1) eight (8) hour working day to instruct Plant Operators for the equipment supplied. The training period will be integrated by the owner with overall training.

1.5 GUARANTEE AND WARRANTY

- A. The equipment shall be unconditionally guaranteed to meet or exceed the design criteria detailed in PART 2 of this Specification section.

PART 2 PRODUCTS

2.1 DESIGN CRITERIA

- A. General: The screw conveyor system was designed around equipment manufactured by Keystone Conveyor Corp or approved equal.
- B. Each screw conveyor shall be a 12-inch diameter shaftless design. Each conveyor shall be designed to handle dewatered sludge, weighing 60-65 PCF, at a future capacity of up to 200 cubic feet per hour.
- C. Each conveyor shall operate at a speed of not more than 30 RPM. The Horizontal Conveyor shall receive sludge from the Belt Filter Press for in-line transfer to the Inclined Conveyor. The Inclined Conveyor shall elevate and discharge the sludge to the loadout dumpster.

2.2 DESCRIPTION OF EQUIPMENT

- A. Shaftless Flighting
 - 1. The sludge screw conveyors are to incorporate 12-inch minimum diameter, full-pitch, shaftless flighting formed from minimum 1" thick x

3" wide, ± 225 Brinell, alloy steel alloy steel spiral. The flighting shall be capable of conveying the product capacity and all horsepower and torque loadings without exceeding .08 in/ft. compression/deflection. The flighting sections shall require field welding by the installation contractor with full penetration welds as recommended by the conveyor manufacturer. The shaftless flighting shall include a bolted connection to the drive shaft.

B. Drive

1. Each conveyor shall be driven by a 3 HP minimum 230/460 volt, 3 ph., 1800 RPM, severe duty motor with 1.15 SF and class F insulation.
2. Drive motors shall be direct connected to an adapter mounted, AGMA Class II, helical gear gearmotor provided at the conveyor trough end.
3. Each drive package is to provide a maximum 30 RPM final screw speed.

C. Trough

1. The conveyor flight shall be housed in a #10 ga. thick minimum type 304 stainless steel U-trough with formed top flanges and integral end flanges.
2. The trough shall include a 3/8" total thickness, replaceable, UHMWP liners from roll line to roll line in the trough interior. Liners shall be in 48-inch max length sections and be held in place with fastener clips as required that do not penetrate the conveyor trough or interfere with the spiral or product conveyed. Liner material shall as manufactured by Durawear, Solidur, or equal.
2. Trough ends shall be 3/8" minimum thickness type 304 stainless steel and will include top flange and support foot.
3. 13" x 13" minimum flanged discharge ports shall be provided at the location shown for discharge to the loadout container.
4. The Tail end of the Inclined Conveyor trough at the tail end shall include a 3-inch minimum diameter drain connection with cap installed.

D. Covers

1. The screw conveyor troughs shall include a 12 ga. minimum cover with gasketing. Covers shall be held in place with stainless steel screw clamps

or bolts on 24-inch maximum centers.

2. 12 ga stainless steel load hopper extensions shall be provided with the Horizontal Conveyor for proper conveyor loading from the screw press.

E. Supports

1. The screw conveyor shall be supported by structural steel members at locations shown on the drawings, spaced no more than 12'-0" on center and including base plates for anchoring to the operating and loadout bay floor. The supports shall be fabricated from 304 stainless steel shapes and plates and cleaned to a uniform finish.

F. Flexible Connections and Chute Extensions.

1. The discharge point of the Inclined Conveyor shall include a flexible chute extension to the elevation shown. Flexible chutes shall be fabricated from minimum 18 oz./yd. vinyl coated polyester.

G. Safety Stop Switch

1. Each conveyor is to be provided with a NEMA-4, 115 V., safety pull cord stop switch. A continuous orange vinyl coated galvanized cable shall fully surround the conveyor. The cable shall be supported from the conveyor frame on 10 foot maximum centers.

H. Zero Speed Switch

1. Each conveyor is to be provided with a non-contacting probe type zero speed indication switch. The probe shall be a Milltronics WM100 or equal with stainless steel mounting hardware. The switch shall have a built-in start-up time delay and zero-speed trip time delay.

2.3 CONSTRUCTION

- A. The screw conveyor spiral shall be HTMAS steel. The conveyor trough, covers and trough ends and supports shall be type 304 stainless steel construction.
- B. All welding to be in accordance with the latest AWS standards.
- C. All component items shall be provided with manufacturer's standard finish. Shafting and other exposed machined surfaces shall be coated with a rust inhibitive compound.

- D. All exposed, accessible rotating parts as well as the drive mechanism to be covered with as OSHA type guard to prevent accidental injury.
- E. All nuts, bolts and washers used for assembly to be stainless steel and installed using an anti-seize compound.

2.4 WORK COORDINATION

- A. Layout and design of the screw conveyor system shall be coordinated with layout of the screw press and sludge loadout area.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Equipment shall be installed in accordance with the manufacturer's recommendations to provide a complete installation.

3.2 ELECTRICAL CONNECTIONS AND CONTROLS

- A. Wiring and conduits for electrical power, controls, instrumentation, and motor starters will be provided by the Electrical Contractor under Division 16 - ELECTRICAL.

** END OF SECTION **

SECTION 462126

WASTEWATER SCREENS

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. Contractor shall furnish all labor, equipment, and material necessary to provide a complete mechanical fine bar screen/auger screen system as shown on the drawings and described in the specifications.
- B. The contractor shall install one bypass screen and one auger screen as shown in the headworks unit design. One control panel will operate both screen systems.
- C. The bar screen system shall be manufactured from Type 304 Stainless Steel unless otherwise indicated. The bar screen system shall not operate on a continuous basis. The screen controls shall enable the screen(s) to be operated on the differential between the upstream and downstream water levels. Ultrasonic level sensors shall be located upstream and downstream of each bar screen to monitor the water levels in the channel and to initiate the operation of the bar screen via the control panel.
- D. Each bar screen shall be designed for an average flow of 0.366 MGD with a peak of 1.0 MGD.

1.2 QUALITY ASSURANCE

- A. It is the intent of these specifications that a single manufacturer-supplier, regularly engaged in the design, manufacture, assembly and production of complete mechanical fine bar screen system of the type and similar size specified, shall have complete unit responsibility for the final design, furnishing, coordination, startup and training of all equipment and components specified herein. The use of multiple manufacturers and/or suppliers to furnish the equipment specified herein shall not be allowed.
- B. The bar screen manufacturer shall stock all spare parts required for the equipment in the United States. The bar screen manufacturer shall have a factory trained service technicians located no more than 200 miles from the plant site.

1.3 QUALITY ASSURANCE

- A. Acceptable Manufacturers:
 - 1. The bar screen equipment shall be supplied by Waco Products Inc., MN Water Treatment Products, or approved equal. The auger screen shall be supplied by Auger Monster or approved equal.
- B. Welding: All shop and field welding shall be performed by qualified welders in

accordance with AWS D1.1.

1.4 SUPPLIER QUALIFICATIONS AND EXPERIENCE

- A. The bar & auger screen manufacturer shall have been in continuous business for a period of at least ten (10) years, engaged in the manufacture of bar/auger screens of the current design and have at least (25) separate installations of the specified design in operation in Tennessee. Screening systems of a design other than that which is specified will not be acceptable references. Only bar/auger screen installations of the specified design shall be acceptable references.

1.5 SUBMITTALS

- A. Submittals shall be made in accordance with the Submittals Section and shall include drawings and documents for the Engineers review to include assembly drawings, anchor bolt positions and size, ratings of equipment, electrical connections, dimensions, bills of materials, wiring diagrams, list of instruments, and any and all other pertinent information. This shall include but is not limited to:
 - 1. Arrangement and erection drawings showing plan and elevation views of the bar screen, screenings compactor, components, and all applicable connections.
 - 2. Working drawings of the controls system including schematic control diagrams, electrical connection diagrams, and complete description of the control systems. Process and instrumentation diagrams shall be included showing all components, flow rates and unit requirements.
 - 3. Details of external termination points, electrical, water lines, drains, etc.
 - 4. List of Materials of Construction
 - 5. Statement of warranty.
 - 6. Any deviation and/or exception to this specification must be detailed and explained with the reason for the deviation and the effect of the deviation on the operation and/ or performance of the equipment.

1.6 EQUIPMENT WARRANTY

- A. The requirements of the General and Supplementary Conditions and the requirements as specified hereinafter shall apply.
- B. Manufacturer shall guarantee all equipment furnished to be free from defects in materials and workmanship under normal use and service for a period of twelve (12) months after the data first placed in service, or eighteen (18) months after delivery, whichever occurs first.

PART 2 -PRODUCTS

2.1 MANUAL BAR SCREEN

A. General

1. Provide one (1) manual bar screen to be mounted inside the headworks structure as shown on the drawings.

B. Materials of Construction

1. Materials and equipment shall conform to the respective publications and other requirements specified and shall be the standard products of a manufacturer regularly engaged in the manufacture of the products:
 - a. Steel ASTM A 36/A 36M
 - b. Cast Steel ASTM A 27/A 27M
 - c. Cast Iron ASTM A 48, Grade 30
2. Unless otherwise stated in this specification, the materials used in the fabrication of the equipment shall conform to the following:
 - a. Frame and Housing AISI 304 SS
 - b. Chutes AISI 304 SS
 - c. Troughs, End Plates, Covers AISI 304 SS
 - d. Supports AISI 304 SS
 - e. Hoppers AISI 304 SS
 - f. Spray Wash System 304 SS
 - g. Bolt, Nuts, and Washers 304 SS
3. All structural steel shall be minimum thickness of 0.20 inch.

C. Manual Bar Screen Description

1. The screen bar blade packages and frame shall be mounted within and flush with the sewage channel. Easy access shall be provided for maintenance of the screen from the front and sides of the unit.
2. The bar screen shall consist of a stationary, manual bar-type screen, operated manually by the operator with the use of the rake provided by the manufacturer.
3. Screens that require influent to pass through more than one set of screening media shall not be considered. Screens which employ a circular moving media that pass through the flow and in the direction of flow to screen debris and then move backwards against the direction of flow to the return position shall not be considered. Screens using bar like porous plating with circular holes will not be permitted.
4. Screens that operate with the possibility of trapping screenings or other materials between screening media will not be permitted. No screen will be considered that has a cross bar for support anywhere in the screening system in the flow except at the absolute top and bottom of the screen

frame.

5. The manufacturer must stock parts in the U.S. which can be delivered from stock. Manufacturers that do not stock parts in the US are not allowed.

D. Frame

1. The frame shall accommodate the bar blade packages, blade cross pieces, and link mechanisms.
2. The frame shall be accurately set into position into the channel and shall anchor securely into place through fixing the support legs to the channel bottom. Embedment into the channel will be required as shown on the drawings.

E. Screen Blades

1. The blades (bars) of the screen shall be accurately set and have plastic spacers to provide a consistent clearance throughout the entire bar cycle. The bars shall be bar shaped with replaceable spacers.
2. The bars shall be contoured in shape, forming a hook from the foot of the bar to the base. Bars with flat, right-angled bars shall not be allowed.
3. The bars shall be a minimum thickness as specified bar width indicated in Paragraph 2.2.B.1.

2.2 AUGER SCREEN & CHANNEL GRINDER

A. General

1. Provide one (1) auger screen as shown on the drawings.

B. Design (Auger screen)

1. The auger screen shall be furnished and installed in conformance with the following data:
 - a. Number of units One (1)
 - b. Manufacturer's name Auger Monster
 - c. Manufacturer's model XS1700-1100-3
 - d. Channel width 16 inches
 - e. Channel depth 36 inches
 - f. Design flow rate:
 - Maximum 1.0 mgd
 - Average 0.366 mgd
 - g. Angle of screen per manufacturer

h.	Differential head	1.28' maximum
i.	Discharge height	48" over top of channel
j.	Maximum motor size	2 HP, 460/3/60

2.2 SUPPORT SYSTEM(S)

A. GENERAL

1. A grinder and auger system support frame with adjustable mounting brackets shall be provided for a 16 inch (406.4 mm) wide and a 36 inch (914.4 mm) deep channel.
2. An auger drive-end support shall be provided as required by the application. The drive end support shall provide a method for pivoting the auger from the channel to perform simple maintenance. Installations with transport lengths of the auger greater than 4000 mm (157 in) shall require additional supports.
3. A horizontal support shall be provided for mounting an ultrasonic sensor upstream from the system support frame.

B. COMPONENTS

The support frame and additional supports shall be of welded square tube, angle, and plate construction. The construction material shall be 304 stainless steel unless noted.

2.3 GRINDER(S)

A. GENERAL

1. Each grinder shall include cutters, spacers, shafts, bearings and seals, side rails, end housings, covers, reducer, and motor.
2. The grinder shall be of two (2) shaft design and be capable of continuous operation, processing wet or dry. Bar screens or single shaft devices utilizing a single rotating cutter bar with stationary cutters shall not be acceptable. Grinders designed with cutter and spacer cartridges rather than individual cutters and spacers shall not be acceptable.

3. Two (2) shaft design shall consist of two (2) parallel shafts alternately stacked with individual intermeshing cutters and spacers positioned on the shaft to form a helical pattern. The two (2) shafts shall counter-rotate with the driven shaft operating at approximately two-thirds (2/3) the speed of the drive shaft. Cutter diameters on the drive and driven shafts shall be of equal diameter to ensure proper clean-out of the spacers.

B. COMPONENTS

1. Individual Cutters and Spacers

- a. The cutting chamber shall be a nominal height of 18 inch (457.2mm).
- b. Individual cutters and spacers shall be a heat treated alloy steel, surface ground for uniformity and through-hardened to a minimum 45-53 Rockwell C.
- c. The inside configuration of both the individual cutters and the individual spacers shall be hexagonal so as to fit the shafts with a total clearance not to exceed 0.015 inch (0.38 mm) across the flats to assure positive drive, minimize wear on the cutters.
- d. Cutter configuration shall consist of individual eleven (7) tooth cam cutters on both shafts. To maintain particle size, the height of the tooth shall not exceed 1/2 inch (13 mm) above the root diameter. Cutter to cutter root diameter overlap shall be not less than 1/16 inch (1.6 mm) or greater than 1/4 inch (6 mm) to maintain the best possible cutting efficiency while incurring the least amount of frictional losses. Clearance between overlapping cutters of opposing shafts shall be no greater than 0.011 inches (0.28 mm).
- e. The cutters shall exert a minimum force at the tooth tip of 1,831 lb/hp (10,921 N/kW) during momentary load peaks.

2. Shafts

- a. Grinder drive and driven shafts shall be made of 4140 heat treated hexagon steel with a tensile strength rating of not less than 149,000 psi (1,027 MPa).
- b. Each hexagonal shaft shall measure a nominal two (2) inch (51 mm) across parallel surfaces.

3. Intermediate Shaft Support

- a. An intermediate shaft support shall be provided in the center of the cutter

stack for grinders with 40 inch (1,016 mm) cutter stack. Grinders with 50 inch (1270 mm) or 60 inch (1,524 mm) cutter stacks shall have two (2) intermediate shaft supports. No support shall be required for required for grinders with 32 inch (813 mm) cutter stacks and less.

- b. The intermediate shaft support shall provide additional support for heavier than normal influent grinder demand loads and protection for the seal assemblies and retaining ring.
- c. The intermediate shaft support shall be made of a cast 303 stainless steel collar and two (2) bushings. The bushings shall act as bearings to allow free rotation of the shafts.

4. Shaft Bearings and Seals

- a. The radial and axial loads of the cutter shafts shall be borne by sealed, oversized, deep-groove ball bearings at each end.
- b. The bearings shall be protected by a combination of a replaceable and independent tortuous path device and mechanical seals.
- c. Face materials shall be of tungsten carbide.
- d. O-rings shall be made of Buna-N elastomers.
- e. Products requiring continuous or occasional lubrication or flushing shall not be accepted.
- f. The mechanical seal shall be rated at 90 psi (620 kPa) continuous duty by the seal supplier.
- g. The bearings shall be housed in a replaceable cartridge that supports and aligns the bearings and seals, as well as protects the shafts and end housings. The seal elements shall be independent of the stack height; therefore cutter stack tightness shall not affect seal performance. The seal elements shall maintain their factory set preload independent of the cutter stack tightness.
- h. Seals shall meet required pressure rating regardless of cutter stack fit. The seal cartridge shall provide seal protection against axial loading on shafts and bearings during shaft deflection.
- i. Each seal element shall be positively locked to its corresponding rotating or static cartridge element. This positive lock on the seal elements is critical to long seal life in applications where grit or other abrasive materials are present.

5. Side Rails

- a. The inside profile of the side rails shall be concave to follow the radial arc of the cutters.
- b. Clearance between the major diameter of the cutter and the concave arc of the side rails shall not to exceed 5/16 inch (7.9 mm).
- c. The side rails shall have evenly spaced slots that increase flow and decrease head loss. The slots shall only be built into the influent side of the side rail and, the effluent side of the side rail shall be void of slots to allow for the maximum flow of the processed effluent.
- d. The side rails shall be cast of A536-84 ductile iron.

6. End Housings and Covers

- a. Grinder end housings shall be of cast A536-84 ductile iron with a cast-in-place flow deflector, designed to protect the bushings while guiding particles directly into the cutting chamber.
- b. Top covers shall be A536-84 ductile iron and bottom covers shall be A36 hot rolled plates.

7. Reducer

- a. The speed reducer shall be a grease-filled planetary-type reducer with a 500% shock load capacity. The reduction ratio shall be 29:1.
- b. The input shaft of the reducer shall be directly coupled to the motor using a two (2) piece coupling, and the output shaft of the grinder shall be directly coupled with the reducer using a two (2) piece coupling.

8. Motor

- a. The motor shall be 5 hp (3.7 kW), Immersible, 1725 rpm, 460 volts, 3-phase, 60-Hz.
- b. Motor service factor shall be 1.15, the efficiency factor not less than 85% at full load and the power factor not less than 80% at full load.
- c. Required Running Torque per Horsepower (kW):
At Momentary Load Peaks: 4,246 lbs-in/hp (643 Nm/kW)

2.4 AUGER

A. GENERAL

1. The auger(s) shall be comprised of a perforated screen segment, transport segment, discharge segment, and drive segment with an internal rotating spiral.
2. Each auger shall be installed at an inclination of 35 degrees from horizontal immediately downstream of the grinder.
3. The auger screen segment trough with a rotating spiral shall provide particle capture and transport to the discharge segment outlet.
4. A wiper/brush shall be affixed to the outer edge of the spiral in the screen segment trough to provide trough cleaning and particle transport. The wastewater shall be permitted to pass through the screen segment and flow downstream.
5. Particles shall be washed both by the highly-agitated passing wastewater and by the discharge of a spray wash system. Dewatering shall occur as the rotating spiral conveys the washed screenings.
6. A spray wash assembly shall be provided to rinse the organic material from the processed solids back into the waste stream. The spray wash system shall consist of a set of nozzles providing a covering spray of water for cleaning the captured solids along with a set of nozzles providing an impact spray to hold the solids against the screen trough for transportability. A spray wash solenoid valve shall be automatically energized by the system controller allowing wash water to spray into the screen segment whenever the auger spiral is in operation. The spray wash solenoid shall be automatically de-energized, stopping the flow of wash water whenever the auger spiral is stopped.
7. Starting of auger run cycles shall be initiated by signals from ultrasonic level sensors.

B. COMPONENTS

1. Auger Spiral

- a. The 285 mm (11 ¼ in) spiral shall be made of high wear-resistant, alloy carbon steel.
- b. The spiral shall have a groove designed into the outside diameter of the spiral for the mounting of the brush. The groove shall securely position the brush so that constant contact is maintained with the screen segment for the purpose of cleaning the perforations and the free passage of soft organics and liquids. Spirals that mount the brush to the face of the spiral shall not be acceptable.

- c. The spiral shall have a welded drive plate for connection to the drive shaft.
- d. The spiral tip speed shall not be more than 33 feet/minute (0.17 m/s).
- e. The spiral transport speed shall not be more than 6.25 feet/minute (0.03 m/s).

2. Screen Segment

- a. The screen segment trough shall be a replaceable, perforated stainless steel assembly. The perforated area of the segment shall be constructed of 14 ga sheet.
- b. The screen trough perforations shall be 6mm for separation of the liquids from the solids. The sharp edges of the perforations shall be removed.

3. Transport Segment

- a. The transport segment shall be a stainless steel assembly with inspection port(s). The segments shall be constructed of 10 ga. Sheet.
- b. The transport segment shall have stainless steel wear bars to support the rotating spiral.

4. Discharge Segment

- a. The discharge segment shall be a stainless steel assembly with an inspection port and a full-width bottom discharge flange. The segment shall be constructed of 10 ga sheet.
- b. The discharge segment shall have a stainless steel endplate for mounting the drive segment.

5. Drive Segment

- a. The drive segment shall be comprised of a drive shaft with welded drive plate, shaft seal, drive adapter spool, speed reducer and electric motor.
- b. The shaft seal shall consist of a packing housing; four (4) PTFE impregnated packing cords, and adjustable packing ring.
- c. The drive adapter spool shall be cast A536-84 ductile iron coated to inhibit corrosion.
- d. The speed reducer shall have a reduction ratio of 160:1.

- e. The electric motor shall be of 2.0 hp (1.5 kW), XPFC, 1725 rpm, 460 volt, 3-phase, 60-Hz.
6. Spray Wash Assembly
- a. The spray wash assembly shall consist of a one (1) inch spray wash manifold, solenoid operated valve, manually operated ball-valve, and a remotely installed basket strainer.
 - b. The spray wash manifold shall be of 304 stainless steel pipes and fittings. The spray nozzle shall consist of 40° “V” spray nozzles rated for 1.5 GPM @ 40 PSI and high impact 50° spray nozzles rated for 1.0 GPM @ 40 PSI.
 - c. The solenoid valve shall be of bronze construction, fitted with an explosion proof enclosure, housing a 120 VAC coil.
 - d. The manually operated ball valve shall be of 316 stainless steel and shall provide adjustment for the spray wash water flow.
 - e. A one (1) inch NPT strainer shall be of SST material, with a 80 mesh 304 stainless steel screen and a threaded drain.
 - f. A one (1) inch NPT double back-flow preventer (not supplied by equipment manufacturer) is recommended when using potable water for spray wash.

2.5 LEVEL SENSORS

A. GENERAL

1. The Auger Monster system shall be provided with upstream and downstream ultrasonic level sensors.
2. The level sensors will initiate auger run cycles based on channel head differential and the parameters set in the operator interface.
3. The PLC logic shall determine differential levels using signals from two (2) separately-mounted ultrasonic level sensors.
 - a. One (1) level sensor shall be installed upstream of the system and measure the system’s upstream water level.
 - b. One (1) level sensor shall be installed downstream of the system and measure the channel’s downstream water level.
 - c. The head in front (upstream) of the system shall be compared to the head behind (downstream) of the system to determine the water level differential.

2.6 MOTOR CONTROLLER(S)

A. GENERAL

1. The controller shall provide independent control of the grinder, auger and spray wash assembly.
2. Controller shall be the supplier's standard UL/cUL listed Model PC-2252D.
3. The controller shall be rated for 5 hp/3.7 kW and 2 hp/1.5 kW, 460 volts, 3-phase, 60-Hz.

B. OPERATION

1. The controller shall be equipped with a GRINDER ON-OFF/RESET-REMOTE three (3) position selector switch.
 - a. In the OFF/RESET position the grinder shall not run.
 - b. In the ON position the grinder will run.
 - c. In the REMOTE position the grinder shall start and stop as controlled by a remotely-located contact.
 - d. The grinder shall only be reset by switching the GRINDER ON-OFF/RESET-REMOTE switch to the OFF/RESET position.
2. The controller shall be equipped with an AUGER ON/OFF/RESET-LEVEL three (3) position selector switch.
 - a. In the OFF/RESET position the auger shall not run.
 - b. In the ON position the auger shall continuously initiate Auger Run Cycles.
 - c. In the LEVEL position, auger run cycles shall be initiated by the ultrasonic level sensors or the Level Sensor Backup Timer. Auger Run Cycles in the LEVEL mode shall only be enabled when the grinder is running.
 - d. The auger shall only be reset by switching the AUGER ON-OFF/RESET-LEVEL switch to the OFF/RESET position.
3. The controller shall be equipped with a digital operator interface.
 - a. The operator interface shall display grinder and auger run times, elapsed

- times, reversals, jams, motor overloads and over-temperature occurrences.
- b. The operator interface shall display Fail, Service Reminder, and Operational Messages.
 - c. Operator interface function keys shall select the following displays: Date and Time, Auger Run Cycle, Auger Start Time Interval, and System Monitor.
 - d. The Auger Cycle Run times, and Level Sensor Backup Timer shall be programmable. Settings shall be entered at the operator interface using panel keys to initiate a desired run sequence.
4. The controller shall be equipped with a programmable Level Sensor Backup Timer.
- a. The Level Sensor Backup Timer shall initiate an auger run cycle if the ultrasonic sensor fails to start an auger cycle within a preset interval of 1 to 999 minutes.
 - b. The Level Sensor Backup Timer shall run the system continually when the timer is set to 0.

C. COMPONENTS

1. Enclosure

- a. Enclosures shall be NEMA 4X, 304 stainless steel construction and shall be suitable for wall mounting. Doors shall have corrosion-resistant hinges and latches.
- b. Enclosure shall house the control devices, relays, terminal blocks and reversing motor starters.

2. Control Devices

- a. Operator interface and pilot devices shall be mounted on the enclosure front panel door.
- b. The controller shall have indicator lights for GRINDER RUN, AUGER RUN, and common FAIL.
- c. POWER ON, GRINDER JAMMED, AUGER JAMMED, GRINDER MOTOR OVERLOAD, AUGER MOTOR OVERLOAD, GRINDER MOTOR OVERTEMP, AUGER MOTOR OVERTEMP, LEVEL SENSOR 1 FAILED, LEVEL SENSOR 2 FAILED and HIGH LEVEL ALARM status messages shall

be displayed on the operator interface.

- d. Control devices are mounted in the front panel of the enclosure. Indicator lights shall be LED type pilot lights. Lights and the selector switches shall be heavy duty NEMA 4X type.
 - e. Control transformer shall be protected by two (2) primary fuses and one (1) secondary fuse. The 120 volt secondary shall have one (1) leg grounded.
 - f. Relay contacts shall be included for GRINDER RUN, AUGER RUN, HIGH LEVEL, and common FAIL signal outputs. The contacts shall be rated 10 ampere, 240 VAC, resistive load.
3. Motor Starters
- a. Starters shall be a full-voltage reversing type with 120 volt operating coils.
 - b. Forward and reverse contactors on the starters shall have both mechanical and electrical interlocks.
 - c. Overload relays (OL) shall be adjustable so that the range selected includes the full load amperes (FLA) rating and service factor.

D. SAFETY FEATURES

1. When a grinder jam condition occurs in the grinder ON or REMOTE mode the controller shall stop the grinder and reverse grinder rotation to clear the obstruction. If the jam is cleared, the controller shall return the grinder to normal operation. Up to two (2) additional reversing cycles (3 times total) may occur within 30 seconds before the controller de-energizes the grinder motor and activates the grinder fail indicator and relay. The auger shall continue operating during a grinder fail condition.
2. When an auger jam condition occurs in the auger ON or LEVEL modes the controller shall stop the auger and reverse auger rotation to clear the obstruction. If the jam is cleared, the controller shall return the auger to normal operation. One (1) additional auger reversal (2 times total) may occur within 30 seconds before the controller de-energizes the auger motor and activates the auger fail indicator and common fail relay. The grinder shall continue operating during an auger fail condition.
3. If a power failure occurs while a grinder or auger is running, operation will resume running when power is restored.
4. If a power failure occurs while the grinder or auger is in a fail condition the fail indicator shall be reactivated when power is restored.

5. The controller shall provide overload protection for the motor through an overload relay mounted directly on the grinder and auger starters.
6. The controller shall be equipped with a main power disconnect switch. Motor branch circuits shall be short circuit protected.
7. Controller reset shall be from the local panel controls only.

PART 3 EXECUTION

3.1 INSTALLATION

Support system(s), grinder(s), auger(s), and motor controller(s) shall be installed in accordance with the supplier's installation instructions, and in compliance with all OSHA, local, state and federal codes and regulations.

SUPPLIER RESPONSIBILITIES

C. Field Services, Start-Up and Training

1. The services of the field representative shall include two (2) trips of one (1) day each for purposes of starting up the equipment.
2. The services of the field representative shall include one (1) trip of one (1) day each for purposes of training the operators on the proper operation and maintenance of the headworks system.

END OF SECTION

SECTION 462185

AUTOMATIC SAMPLING EQUIPMENT

PART 1 - GENERAL

1.01 RELATED WORK:

- A. Division 40 - Mechanical
- B. Division 26 - Electrical.

1.02 SCOPE:

Furnish and install two (2) automatic liquid samplers; one (1) for the plant influent and one (1) for the plant effluent as shown on the Drawings and described in the Specifications.

1.03 TOOLS AND TEST EQUIPMENT:

- A. Six (6) complete sets of Operation and Maintenance Manuals shall be provided.

1.04 SPARE PARTS:

- A. Miscellaneous Spare Parts:
 - 1. One (1) year supply of the manufacturer's recommended spare parts for the equipment furnished.
 - 2. The spares listed above shall be packed in a manner suitable for long-term storage and shall be adequately protected against corrosion, humidity and temperature.

1.05 EQUIPMENT MANUFACTURER:

- A. Manufactures for flow metering equipment are as follows:
 - 1. Teledyne Isco 6712FR Refrigerated Sampler
 - 2. Approved Equal.

PART 2 – PRODUCTS

- 2.01 The sampler is to be weather and corrosion resistant, appropriate for exterior use in a wastewater environment.
- 2.02 The refrigerated sampler cabinet shall be constructed of corrosion resistant, linear low density polyethylene. The sample compartment door shall have a compressible gasket seal and positive mechanical latch. The cabinet shall be insulated to promote temperature stability. A built in heater prevents freezing in cold conditions.
- 2.03 Stainless steel components of the refrigeration system shall be powder coated to protect against corrosion from a wastewater environment.
- 2.04 Sampler shall deliver samples with a minimum line velocity of 2 ft/sec and head heights of 25 ft.
- 2.05 Sampler operational temperature to -20 F to 120 F.
- 2.06 Sampler shall use a 3/8" diameter suction tubing made of vinyl or FEP-lined PE.
- 2.07 Sample volumes can be programmed 10 to 9,990 ml in 1 ml increments.
- 2.08 Sampler shall be equipped with a NEMA 4X, 6 IP67 enclosure and shall accept flow meter signal input. Sampler shall have adjustable sampling frequency, modes and volumes.
- 2.09 The samples shall have the built-in and switch selectable capability for both timed cycle and flow proportional sampling. The interval shall be adjustable from 1 to 9999 minutes in one-minute increments. In the flow proportional mode, the sample shall have both the capability to accumulate 1 to 9999 contact closures or receive a 4-20 mA signal.
- 2.10 The sampler shall operate as a composite unit.
- 2.11 The sampler shall be provided with one (1) 20 liter PE bottle container.
- 2.12 The sampler shall operate from 115 Vac power.
- 2.13 Exterior dimension of the sampler shall not exceed 52.25" x 29" x 33".
- 2.14 The sampler shall be supplied with a 4-20 mA input capability for flow paces sampling from an external flow meter.
- 2.15 All parts and components of the sampler shall be suitable for exterior installation in a corrosive environment.
- 2.17 All necessary SCADA contacts required in the MR Systems appendix shall be included with the samplers.

PART 3 - EXECUTION

3.01 GENERAL:

All components shall be installed and tested in accordance with the manufacturer's written instructions.

3.02 INSTALLATION:

The Contractor is responsible for the complete furnishing and installation of both the influent and effluent samplers. The Contractor is responsible for supplying the required inlet and outlet piping for withdrawal and disposal of the sample. The Contractor is responsible for all electrical and instrumentation connections.

3.03 WARRANTY:

All components shall be warranted one year from the final acceptance of the system.

END OF SECTION

SECTION 463300

CHEMICAL FEED SYSTEMS

PART 1 – GENERAL

1.01 DESCRIPTION

A. Work specified

1. The furnishing and installation of the chemical feed system including metering pumps, drive motors, pump controls and all piping and appurtenances required for a complete operating installation as shown on the contract documents. All chemical feed equipment shall be skid mounted and installed in an FRP enclosure.
2. The chemical feed pumps and systems shall be as manufactured by Grundfos, SS Process Equipment, Rochester, NY, Jm Dismuke Co, Tech Equipment or approved equal.
3. Complete feed system includes the installation of storage and day tanks as specified in the drawings and all assorted piping for a fully operational system.

B. Related work specified elsewhere (not provided)

1. General Equipment Requirements
2. General Provisions
3. Valves and Appurtenances
4. PVC Pipe Hangers and Fittings
5. Pipe Hangers and Supports

1.02 SUBMITTALS: Submit for approval the following:

- A. Manufacturer's literature, illustrations, specifications, and engineering data including dimensions, materials, size, weight, performance data, required net inlet pressure, flow rate, motor horsepower and speed.
- B. Operation and Maintenance Manuals
- C. Performance affidavits from the manufacturer certifying to the Contractor and City jointly that the equipment meets in every way the required performance.

1.03 QUALITY ASSURANCE

- A. All work under this specification shall be the responsibility of the Contractor.

- B. The manufacturer of the chemical feed metering pumps is responsible for meeting the requirements of this specification and related work specified elsewhere (including but not limited to section 1.01B). In addition, they shall coordinate operation of their equipment with the Contractor including but not limited to:
1. Providing any and all information on the performance/characteristics of their equipment.
 2. Providing wiring and installation diagrams, operational and shutdown interlocks and ancillary controls.
 3. Providing shop drawings, parts lists, materials of construction, tolerance, coatings, and certification of compliance with generally accepted standards.

1.04 SPARE PARTS

- A. Each chemical metering pump shall be provided with the following as applicable:
1. One replacement tube element.
 2. One spare parts kit including all diaphragms, check valve assemblies and O-rings required to refurbish the metering pump wet-end.

PART 2 – PRODUCTS

2.01 PERISTALTIC METERING PUMPS

A. Construction

The chemical feed pump shall be of the peristaltic tube type wherein a rotating roller compresses the hose / tube element between the rollers and pump housing. Each revolution of the compression roller shall discharge a precise amount of process fluid.

1. There shall be no valves, diaphragms, springs or dynamic seals in the fluid path. Process fluid shall contact the pump tubing assembly and connection fittings only.
2. Pumps shall be self-priming and capable of pumping against back pressures up to 150 psig.
3. Each pump shall be provided with a tube leak detection system integral to the pump head. Tube leak detection systems shall not trigger when exposed to water. Pumps relying on float type leak sensors or systems which include leak ports / drains shall be unacceptable.

4. Squeeze rollers with encapsulated ball bearings shall be directly coupled to a one piece thermoplastic rotor. Four polymeric rollers shall be provided; two squeeze rollers for tubing compression shall be located 180 degrees apart and two guide rollers that do not compress the tubing shall be located 180 degrees apart. The roller diameters and occlusion gap shall be factory set to provide the optimum tubing compression, field adjustment shall not be required. Spring loaded or hinged rollers shall be unacceptable.
5. The pump rotor assembly shall be installed on a D-shaped, chrome plated motor shaft and shall be removable without tools.
6. During tubing installation and removal the pump rotor assembly shall be rotated by the motor drive at 6 RPM maximum while the pump head cover is removed. Hand cranking of the rotor assembly shall not be required.
7. The pump head cover shall be a clear annealed acrylic thermoplastic with an integral ball bearing fitted to support the overhung load on the motor shaft. The pump head cover shall include an imbedded magnetic safety interlock which will limit the motor rotation speed to 6 RPM when removed. Pump head cover removal shall not require the use of special tools.
8. Pump connection fittings shall be permanently clamped to the tubing with stainless steel clamps. Fittings shall insert into keyed slots located in the pump head and be secured in place by the pump head cover. All tube fittings shall be of PVDF construction and shall be either NPT or tubing connections.
9. The pump drive system shall be totally enclosed in a NEMA 4X washdown enclosure. Pumps shall operate on 115V, 1 phase power supply and include an integral reversible brushless DC gear motor with a maximum 125 RPM. Pumps rotating above 125 RPM shall not be accepted.

B. Performance (SOME VALUES TBD)

SERVICE	QTY	MAX. CAPACITY (GPH)	MAX. PRESSURE (PSI)	TUBE
SODIUM HYPOCHLORITE	2	3	125	NORPRENE
SODIUM BISULFITE	2	1	125	NORPRENE

C. Control

1. Control circuitry shall be integral to the pump and capable of adjusting the pump motor speed from 0.05% to 100.00% in 0.01% increments when motor speed is less than 1% and in 0.1% increments when motor speed is greater than 1%. Total pump turndown shall be a minimum of 1,000:1.

2. Pump output shall be capable of being remotely control via 4-20mA analog input. The input resolution shall be 0.01 of input value and capable of adjusting the pump motor speed from 0% to 100.0% motor speed in 0.1% increments. Four values shall be user configurable to define the low and high points on the output slope; a low input value, the required pump percentage of motor speed at the low input value, a high input value and the required pump percentage of motor speed at the high input value.
3. The pump shall be capable of dispensing upon demand. The dispensing shall be manually triggered by pressing the front panel start button or by inputting a contact closure. The dispensing volume shall be adjustable from 1 to 9999 milliliters. Pump motor speed during the dispensing cycle shall be adjustable from 0% to 100.0% motor speed in 0.1% increments.
4. The pump shall be capable of automatically calculating the pump motor speed required to achieve a part per million dosing output that is proportional to a fixed system flow rate. The pump controller shall permit the user to input the dispensing chemical percentage concentration from 0% to 100.0% in 0.1% increments. The pump shall permit the user to input the dispensing chemical specific gravity from 0.1 to 9.9 in 0.1 increments. The pump shall permit the user to input the fixed system flow rate from 1.0 to 9999.9 liters per minute in 0.1 liters per minute increments. The pump shall permit the user to input the required dosing parts per million (PPM) from 0.1 to 100.0 in 0.1 increments.
5. The pump control interface shall include a 10-button front panel user touchpad. Touchpad shall include stop/start functionality, configuration menu access and navigation, operating mode selection, auto priming, display options selection and reverse direction.
6. The pump controller shall include a multi-color VGA graphic LCD display for menu driven configuration settings, pump output value, service alerts, tube failure detection system, alarms status, remote input signal values and tubing life timer value. Display color shall be green when indicating normal operation, blue when in stand-by and red to indicate an alarm condition.
7. Pumps shall be capable of remote stop/start via 6-30 VDC powered loop or non-powered contact closure loop.
8. Each pump shall include four contact closure alarm outputs. Three outputs shall be rated at 1A-115VAC, 0.8A-30VDC and one shall be rated 6A-250VAC, 5A-30VDC. Each alarm output shall be assignable to any of the following pump functions: tube failure, motor run/stop, motor failed to respond to commands, input signal failure, output signal failure, or remote/local control setting.

2.02 CHEMICAL FEED SYSTEM

A. Construction

1. Each chemical feed system shall be completely assembled, mounted, calibrated, tested, and delivered to the site on a single wall mount skid. Components to be mounted on the skid are as indicated on the drawings and shall include metering pumps, piping, valves, piping accessories (calibration columns, pressure relief valves, Y-strainers and pressure gauges etc. as detailed in the drawings), and wiring integral to the skid.
2. Chemical feed skids shall be constructed of welded high density polyethylene. Materials such as stainless steel, aluminum or PVC will not be acceptable for skid base and backer.
3. Clear PVC piping shall be used between the Y-Strainer and pump suction valve. This will allow a visual inspection of the liquid in the injection line during operation. Additionally, clear PVC piping shall be used from the pressure relief valve back to the suction piping to allow visual verification of relief flow.
4. All PVC piping and fittings shall be schedule 80 and readily available locally. Special machined fittings/blocks that are not of standard manufacture will not be accepted.
5. Feed system piping shall include an air bleed/flush connection on the suction and discharge of each pump. The bleed/flush connections should be located on the interior of the pump isolation valves to allow for all lines to be purged of air after the bulk tank is filled and allow the pump to be flushed prior to maintenance being performed.
6. Feed system design shall be such that the wetted end of the pump is orientated at the open end of the framework for easy access. Systems designed with the wet end of the pump facing the back wall of the skid shall not be acceptable. Systems designed without the pump mounted control interface facing the front open end of the skid shall not be accepted.
7. The feed system suction header shall include one Y-strainer. The Y-strainer material of construction shall match the piping material. Y-strainers shall have a 2:1 open area ratio, 1/32 inch screen perforations and be equipped with a hex cap for easy screen access. Connections shall be either socket, flanged or compression type.
8. One calibration column shall be supplied with each metering pump. The calibration column shall be constructed of clear PVC. Graduations shall be in milliliters and it shall be sized for a minimum 30 second drawdown when the metering pump is operating at 100% capacity.
9. One pressure relief valve per pump shall be installed in the discharge piping. Pressure relief valves shall be of the 2-port design and shall be equipped with

socket, flanged or compression connections. Pressure relief valves shall be field adjustable from 10 to 150 psig without the need for special tools.

10. One discharge pressure gauge and diaphragm seal assembly shall be supplied with each system discharge. The 4" pressure gauge shall be rated 0-160 psig, have a white face with black lettering and be of phenolic construction. Diaphragm seals shall match the piping material of construction, utilize a bonded diaphragm and be supplied with 0.50-inch socket or flanged process connection.
11. All piping / accessory support shall be from skid base or rear panel. Piping / accessory support from above is not acceptable.

2.03 CHEMICAL FEED FRP SHELTER

A. Construction

1. Contractor to purchase and install a modular shelter to house pump skid. Shelter shall include FRP construction in the dimensions shown on the drawings.
2. Shelter shall have 1 ½" foam in place insulation, sloped roof, one 3'-0"x6'-4" FRP door, all stainless steel hardware.
3. Shelter shall also include fluorescent lights, one exhaust fan and lower air intake. One exterior light to be provided at door.
4. Shelter shall be equipped with appropriate receptacles and toggle switches for the installation of chemical feed skid.
5. Shelter shall be shipped per assembled with suitable lifting brackets for installation.

END OF SECTION

SECTION 464321

BRIDGE SUPPORTED CLARIFIER

PART 1 - GENERAL

1.01 DESCRIPTION.

- A. There shall be furnished two (2) clarifier mechanisms each suitable for installation in concrete basins as shown on the contract drawings. Each basin shall be 30 feet in diameter with a side water depth of 14.5 feet, a freeboard of a minimum 24 inches and a floor slope of 1 inch to 12 inches.
- B. Each mechanism shall be supported on the walkway spanning the tank with the flow entering the side of the tank and flowing into the feedwell through an influent pipe. Effluent will be collected in a peripheral submerged launder and a center drive mechanism shall be provided for rotation of the two rake arms with rake blades.
- C. The equipment shall be designed to effectively settle mixed liquor suspended solids and scrape the settled solids from the basin floor to the sludge withdrawal sump as shown on the drawings. The clarified effluent shall be collected uniformly by the peripheral launder. Surface scum shall be collected by the scum skimming equipment and discharged through the scum withdrawal pipe.
- D. The equipment furnished for each clarifier mechanism shall include but not be limited to: walkway with handrails, center drive assembly, center drive platform, feedwell, center shaft, sludge collection arms with rake blades, surface scum skimming equipment, effluent launder, anchor bolts and assembly fasteners.
- E. Except where specifically indicated otherwise, all plates and structural members designated for submerged service shall have a minimum thickness of 1/4 inch. All structural steel will conform to ASTM A-36 requirements and steel plate will conform to ASTM A283C requirements. All anchor bolts used to secure the mechanism to the tank shall be 304 stainless steel. All assembly fasteners shall be 304 stainless steel.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. CONCRETE Division 3
- B. STEEL MATERIAL Division 5
- C. FINISHES Division 9
- D. ELECTRICAL/CONTROLS Division 26

1.03 PROCESS REQUIREMENTS

A.	Design average flow;	(0.366) MGD
B.	Design Peak flow;	(1.000) MGD
C.	Design average recycle flow;	(0.458) MGD
D.	Design peak recycle flow;	(1.144) MGD
E.	Drive continuous torque;	9,700 ft.lbs.
F.	Drive 100% design torque;	15,000 ft.lbs.
G.	Drive momentary peak torque;	36,600 ft.lbs.
H.	Mechanism rotation;	Clockwise.
I.	Rake arm tip speed;	10-12 ft./min.

1.04 DESIGN REQUIREMENTS

A.	Basin diameter	30'
B.	Side water depth	14'-6"
C.	Tank freeboard	24"
D.	Floor slope	1:12
E.	Feedwell diameter	6'-0"
F.	Feedwell submerged depth	3'-7"
G.	Center Shaft`	6" SCH 40
H.	Rake arm minimum size	2'-10" square
I.	Spiral blade height at tank wall	5"
J.	Spiral blade height near tank center	16"
K.	Scum trough width	3'-0"

1.05 REFERENCES.

A.	ASTM A-36	American Society of Testing Materials Structural Steel Specifications
B.	ASTM A-325	American Society of Testing Materials Fastener Specifications
C.	ASTM 304	American Society of Testing Materials Bolt Specifications
D.	ASTM A-48	American Society of Testing Materials Cast Iron Specifications
E.	ASTM A-536	American Society of Testing Materials Cast Iron Specifications
F.	AISI 4142	American Iron and Steel Institute

Heat Treated Steel Specifications

- G. AGMA American Gear Manufacturers' Association
Gear Ratings
- H. AWS American Welding Society - Current Standards
- I. AFBMA Anti-friction Bearing Manufacturers'
Association - Bearing Life Specifications
- J. ASTM A283C American Society of Testing Materials
Steel Plate Specifications
- K. NEMA National Electrical Manufacturer's
Association Motor Design Standards and Standards for
Control Enclosures

1.06 QUALITY ASSURANCE.

- A. The clarifier equipment manufacturer shall modify his standard equipment to meet the minimum values specified for dimensions, design, and the intent of this specification.
- B. The clarifier equipment will be manufactured by Ovivo or engineer approved equal.
- C. Manufacturers regularly engaged in the manufacture of the clarifier equipment as specified herein and who can demonstrate equipment of this specified design, in actual service for a period of not less than 10 years will be considered as acceptable manufacturers.
- D. Manufacturers shall show evidence of quality assurance in manufacturing and supplying equipment essential in details to the equipment herein specified. This assurance will be met by certification to the quality system requirement of ISO 9001 or equivalent standard as accepted by the engineer.
- E. Manufacturers not named in the specification and meeting the requirements as set forth in paragraph C and D must submit to the Engineer, 15 working days prior to the bid date, detailed information describing how their proposed equipment will meet the specification. The detailed information shall include, but not be limited to dimensional data, materials of construction and an installation list with address, telephone number, and an individual's name directly employed by the owner of the equipment. Plan holders will be notified of approved manufacturers by addendum, five (5) working days prior to bid date.

1.07 CONTRACTORS SUBMITTALS.

- A. The contractor shall submit complete shop drawings of all equipment furnished for this project as covered by these specifications. The contractor's submittal must include a certification that the submitted material describes exactly the equipment to be provided. Substitutions of equipment subsequent to submittal approval will not be accepted.
- B. The clarifier equipment manufacturer shall furnish as a minimum the following design and description information to establish compliance with these specifications:
 - 1. Certified general arrangement and tank dimensional drawings.
 - 2. Certificate of design stamped by a Registered Professional Engineer stating that the equipment to be provided for this project meets or exceeds all design requirements of these specifications. The certificate shall state the respective loads and design criteria.
 - 3. Drive mechanism rating calculations, stamped by a Registered Professional Engineer, verifying the compliance of the drive gears and bearings with the specified continuous torque rating and bearing life rating.
 - 4. Motor data and catalog information. Electrical drawings as applicable to the supply of the clarifier equipment manufacturer.
 - 5. Catalog cut sheets for purchased sub-components.

1.08 OPERATION AND MAINTENANCE MANUALS

- A. Operation and maintenance manuals will be provided by the clarifier manufacturer at least two weeks prior to shipment of all major equipment components. Each manual shall be a bound, indexed binder with drawings and parts lists prepared specifically for this project rather than general instructions that are not designed for this project.
- B. As a minimum the manual shall contain:
 - 1. Certified as built drawings
 - General arrangement
 - 2. Certified as built drawings
 - General arrangement details
 - 3. Erection drawings.
 - 4. A complete bill of materials for the equipment including the weights of all structural steel components.

5. Installation and maintenance instructions for the specific equipment including the erection sequence, maintenance and trouble-shooting check points, and complete lubrication procedures with recommended grades of lubricants.
6. Cut sheets for all equipment items purchased from sub-vendors.
7. A list of the clarifier manufacturer's recommended spare parts specifically denoting wear items, long delivery items, and all items convenient for stocking as optional replacement items.

1.09 DELIVERY.

- A. Fabricated assemblies shall be shipped in the largest sections permitted by carrier regulations, properly match-marked for ease of field erection.
- B. All components shall be erected immediately upon receipt from the clarifier manufacturer or stored in strict conformance with storage recommendations provided by the clarifier manufacturer in the operations and maintenance manual.
- C. The mechanism shall be lubricated in strict accordance with the instructions of the clarifier manufacturer's field service representative. The required lubricants shall be provided by the contractor.

PART 2 - PRODUCT

2.01 GENERAL.

- A. Each clarifier mechanism shall be of the center-drive type, completely supported by the walkway, with the flow entering the side of the tank and flowing into the feedwell through an influent pipe. The clarifier shall be designed to remove sludge uniformly from the bottom of the tank.

2.02 CENTER DRIVE ASSEMBLY.

- A. The center drive assembly shall consist of an integral motor and primary speed reducer coupled through roller chain and sprockets to a secondary final output worm gear reducer and shall have an integral overload protection system.
- B. All gears and bearings shall be oil bath lubricated with the rolling elements of the main bearing totally submerged in oil and the teeth of the worm gear at least partially submerged in the oil bath. The meshing action of the gears shall force the oil onto all surfaces. Oil pumps for lubrication or grease lubricated bearings are not considered appropriate for this application and will not be allowed. The oil reservoir for the main bearing and gear shall have a section of minimum depth 2" inches below the main bearing to positively prevent contamination of the main bearing and gears with condensate or other contaminants. Gear and bearing housings must also

be fitted with oil level sight glasses and condensate drains. Condensate must be allowed to drain from a low point of the housing. In lieu of the oil reservoir depth requirement a continuous oil conditioner unit installed at each drive assembly and as specified herein will be considered equal. The conditioner shall consist of an electrical continuous pre-pump filter and 150-micron stainless steel oil filter. All conditioner mounting hardware, electrical wiring/controls and necessary piping shall be provided by the clarifier manufacturer.

- C. Drive components will be located via a machined, registered fit to preserve the alignment of key drive components under all load conditions. Inspection of the completed drive unit shall be accomplished at the clarifier manufacturer's shop, with reports of all tests and certifications of material hardness being made available for review at the Engineer's request prior to shipment to the job site.
- D. Major drive components, worm gears and bearings must be designed to allow for separate and individual replacement by plant personnel to facilitate quick and economical repairs.
- E. The complete center drive assembly, including the overload protection device, shall be a regularly manufactured in-house product of the clarifier manufacturer. The center drive assembly is a key element in a successful clarifier installation, therefore drive assemblies purchased from third party vendors will not be accepted.
- F. The drive motor shall be minimum 3/4 horsepower and shall be totally enclosed, fan cooled, with a 1.15 service factor, and have bearings with a minimum B10 rating of 50,000 hours. Operating electric current will be 230/460 volt, 3 phase, and 60 hertz. Each motor will be NEMA Design B employing Class F insulation designed for an ambient temperature of 40 degrees C.
- G. The gearmotor primary speed reducer shall drive the final worm gear reducer through a #60 roller chain and steel sprockets enclosed in a galvanized 22-gauge steel guard. Sprockets and chain shall be designed for the connected horsepower of the drive with a minimum service factor of 1.4. Provision shall be made for adjustment of chain tension.
- H. This final output reducer shall be a worm and worm gear reducer specifically designed for this application. The worm shall be hardened alloy steel.

The worm gear rim shall be solid one piece centrifugal cast manganese bronze of 65,000 PSI tensile strength and have a nominal 21 inch pitch diameter and be supported by and rotate on the main bearing. The rotating center shaft to which the rake arms are attached shall be bolted to the worm gear hub. The gear shall be removable without disturbing the walkway or platform. Gear diameter must be increased in size for cast iron gears.

- I. The main bearing shall have a minimum pitch diameter of 16.25 inches to assure stability without the necessity of underwater guide shoes and shall include chrome

alloy steel balls, minimum 0.75 inch diameter, which shall bear vertically and horizontally upon a four point contact precision bearing assembly fitted into the turntable base and the worm gear. The bearing assembly shall be such that the B-10 life of the liner is a minimum of 50 years based on the mechanism speed and a uniformly distributed load due to the rotating mechanism.

- J. The bearing life shall be based on the life to initial pitting of the bearing race.
- K. Drives using integral bearing / gear assemblies will not be allowed. The gear must be replaceable independent of the bearing assembly.
- L. In no case will mechanisms be allowed which use lower guide bearings, feedwell bearings, or have chains, sprockets or any part of the drive unit below the top of walkway beams.
- M. The wormgear and bearing shall be completely enclosed in a cast iron housing provided with neoprene dust seals. In order to ensure the maximum possible base rigidity, the gear housing shall be of full sidewall construction, integral with the base. Prior to assembly, the base shall be thoroughly inspected for seep holes or inclusions and given a hydrostatic test to ensure no leaks are in the oil containment area. Shop inspection reports must be made available for review.
- N. The drive unit shall be equipped with an electro-mechanical overload control device actuated by thrust from the worm shaft. The pointer shall provide a visual reading of the relative worm gear output torque on a 0 to 100 percent graduated scale. The 100 percent reading shall equal the 100 percent drive rating as specified in section 1.03. The control device shall also activate an alarm switch for warning of impending overload, a motor cutout switch for overload protection and a back-up safety motor cutout switch for back up overload protection. In lieu of a back-up safety motor cutout switch a slip clutch assembly will be acceptable upon review by the Engineer. The respective switches in the overload control device shall be factory calibrated and set to the following settings;
 - Alarm; 40% of scale.
 - Motor cutout; 85% of scale.
 - Back-up motor cutout or slip clutch; 100% of scale.

All drive control components shall be mounted in a NEMA 4X enclosure of either epoxy coated aluminum construction or stainless steel with a gasket sealed removable cover. The pointer shall be covered with a plexi-glass enclosure and shall be above the walkway surface for visibility from the walkway. Amperage sensing devices are not acceptable for torque overload protection due to their inability to react quickly enough to prevent damage to the drive. Overload devices with exposed linkage connections will not be accepted due to possible corrosion problems.

- O. The center drive unit shall be designed for the continuous torque rating as specified in section 1.03. The continuous torque shall be defined as the minimum torque at which the drive mechanism may operate continuously 24 hours per day, 365 days per year, for 20 years, at the specified sludge collector arm speed.

Worm gearing shall be designed and rated to equal or exceed the specified continuous torque and life. The basis for rating shall be ANSI/AGMA 6034-A87 (March 1988) standards for durability rating and design of wormgear reducers.

2.03 WALKWAY ACCESS BRIDGE

- A. The clarifier shall be provided with a 36 inch clear open width walkway extending from the tank wall to the center drive platform. The walkway shall span the tank and be supported by the tank walls. As a minimum the walkway shall be designed to safely withstand all dead loads plus a live load of 50 pounds per square foot with a maximum deflection of 1/360, over the entire span. The walkway shall consist of two (2) beams, minimum W14 x 22 lbs. each. These beams shall be sufficiently braced to resist the specified design loads. The walkway decking shall be 1-1/4 inch x 3/16 inch aluminum grating.
- B. A center drive operations platform shall be provided. It shall be a minimum of 7 feet square to provide clearance around the center assembly and drive control for maintenance and service. The drive platform shall be decked with 3/8 inch aluminum checkered floorplate and have sufficient structural steel supports to meet the specified design load conditions.
- C. Provide handrails with toe plate along both sides of the walkway and around the center drive platform. The handrailing shall be in conformance with the handrail specifications, found within this set of bid documents, and shall be as shown on the drawings.

2.04 CENTER SHAFT AND RAKE ARMS.

- A. The center shaft shall be steel pipe, 6" Schedule 40. It shall be provided with connection points for the two sludge removal arms and feedwell supports. The shaft shall be bolted to the worm gear to rotate the attached arms, feedwell and skimmer assembly.

The minimum angle size used for construction of the center shaft and rake arms shall be 2 inch x 2 inch x 1/4 inch members.

- B. The clarifier mechanism shall include two (2) sludge removal arms of steel truss construction, a minimum of 2 feet 10 inches square with steel raking blades and adjustable 20 gauge 304 stainless steel squeegees. The rake blades shall be properly spaced to insure complete raking of the basin floor twice per revolution.

- C. The center shaft and rake arms shall be designed such that calculated stresses do not exceed the AISC allowable stress at twice the drive 100% rating.

2.05 INFLUENT PIPE

- A. There shall be provided a 16" dia. steel influent pipe, minimum 1/4" wall thickness. The pipe shall include a 125# Class ANSI steel flange for bolting to incoming influent line and shall include an elbow and energy dissipating tee at the inlet. The pipe shall include all necessary supports and be located below the rotating feedwell to allow for the rotation of the skimmer assembly.

2.06 FEEDWELL.

- A. The feedwell shall be 8 feet diameter x 4 feet 1 inch side depth supported by structural members attached to the center rotating center shaft. The feedwell shall be fabricated of 1/4 inch steel plate with upper and lower reinforcing rim angles and stiffeners as required. A minimum of two (2) scum ports, 4 inches high x 16 inches long, shall be provided equally spaced around the feedwell periphery to allow scum to exit from the feedwell at water level. Scum ports shall be free to allow scum to escape with an angled baffle plate to impart a tangential direction of the flow exiting the scum port.

2.07 SUBMERGED EFFLUENT LAUNDER

- A. There shall be furnished two (2) Submerged Effluent Launder™ (SEL™) system suitable for installation in a concrete basin as shown on the contract drawings if the base bid is selected. The contractor may use an engineer approved equal if the alternate bid is selected.
- B. Each SEL™ system shall consist of the following:
- Self-supporting fiberglass reinforced plastic submerged effluent launder (SEL™) for mounting on the tank wall. Includes all 304SS anchors and fasteners.
 - SEL™ surface sweeping mechanism with 304 SS fastening hardware.
 - Flow control gate with anchors.
 - Two (2) level sensors with mounting hardware
 - Pre-programmed local control panel with PLC.
- C. Material: Laminated fiberglass reinforced Isophthalic polyester resin, nominal 1/4 inch thickness; inside surface shall have a smooth gel-coat resin finish; outside surface gel-coat resin seals exposed glass fibers; color molded-in with ultraviolet inhibitor. All cut edges shall be sealed with polyester resin.
1. Glass Type E, random chopped with chrome or silane finish, a binder compatible with the resin, glass strand length one (1) inch minimum.

2. Adequate contact molding pressure ensures complete resin wet-out of glassfibers.
 3. Fiberglass fiber weight, nominal 25 percent.
 4. Color: Aqua.
- D. The SEL™ shall eliminate the need for traditional surface level “U” shaped launders, launder covers, algae cleaning systems, scum baffles, density current baffles and effluent weirs. The SEL™ shall be designed to provide an even effluent flow distribution at the tank perimeter and minimize algae growth.
- E. Each Submerged Effluent Launder™ shall be a tank perimeter mounted submerged effluent launder with flow entering horizontally oriented equally spaced ports of varying size on the effluent launder upper panel. The submerged effluent launder discharge flow rate shall be automatically controlled using a control gate. The Submerged effluent launder shall be designed to remove effluent liquid uniformly at the tank perimeter.
- F. The SEL™ shall be self-supporting and fabricated of fiberglass reinforced plastic. It shall be comprised of an upper and lower launder plate.
- G. The upper launder plate includes three sections that serve five functions. The upper section is a vertical plate that functions as a scum baffle and as a connection point to the clarifier tank wall. The middle section, integral to the upper and lower section and angled downwardly and obliquely, functions as the upper boundary of the submerged launder. In addition, orifices are located near the bottom of the middle section to collect clarifier effluent. Orifices are significantly submerged to minimize sunlight to minimize algae growth serving the function of a launder cover. The lower section is integral to the upper and middle section and angled downwardly and obliquely, extending below the lower launder plate serving as a density current baffle.
- H. The lower launder section serves as the bottom boundary of the submerged launder. It is anchored to the clarifier tank wall and is fastened to the upper launder section above the density current baffle section and below the orifices.
- I. The SEL™ shall not exceed the following design parameter:
- Maximum headloss of 4.03 inches through the SEL™.
 - Maximum internal launder flow velocity 4 fps.
 - Maximum orifice velocity 6 fps.
- J. The following SEL™ parameters shall be calculated using the OVIVO USA, LLC proprietary sizing program:
- Orifice diameter, depth and spacing.
 - Total number of orifices.
 - Upper launder plate angle of projection from horizontal plane.

- Length of density current plate.
- Headloss
- Maximum launder internal flow velocity.
- Maximum orifice velocity.
- Flowrate of each orifice to ensure flow rate is evenly distributed to each orifice within a standard deviation of $\pm 6\%$ at design flow conditions.

2.08 QUALITY ASSURANCE

- A. The Clarifier SEL™ system shall be manufactured by Ovivo USA, LLC. Approved equal manufacturers may be accepted by the engineer if the alternate bid is selected. No alternates will be accepted if the base bid is accepted.

2.09 REFERENCES

- A. ANSI/NSF 61: NSF International for Drinking Water System Components, Health Effects.
- B. ANSI/ WWA F101: American Water Works Association for Contact Molded Fiberglass Reinforced Plastic, Wash Water Troughs, SEL's and Launderers.
- C. ANSI/AWWA F102: American Water Works Association for Matched-Die-Molded Fiberglass Reinforced Plastic Weir Plates, Scum Baffles, And Mounting Brackets
- D. ANSI: American National Standards Institute
1. ASTM D-256; American Standard Test Methods for Determining the Pendulum Impact Resistance of Notched Specimens of Plastics.
 2. ASTM D-570; American Standard Test Methods for Water Absorption of Plastics
 3. ASTM D-618; American Standard Test Methods Practice for Conditioning Plastics and Electrical Insulating Materials for Testing
 4. ASTM D-638; American Standard Test Methods for Tensile Properties of Plastics
 5. ASTM E 831; American Standard Test Methods for Coefficient of Linear Thermal Expansion of Plastics Between -30 Deg F and 30 Deg F.
 6. ASTM D-790; American Standard Test Method for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
 7. ASTM D-2583; American Standard Test Methods for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor.

2.10 SUBMITTALS

- A. Product property data generated from the fiberglass reinforced plastic contact molded laminate.
1. Shop Drawings Depict:

2. Critical dimensions, jointing and connections, fasteners and anchors.
 3. Materials of constructions.
- B. Sizes, spacing, and locations of structural components, connectors, attachments, adjustments, openings, and fasteners.
 - C. Manufacturer's installation instructions.

2.11 SEL™ SCUM BOX SWEEPER.

- A. Surface scum skimming equipment shall be furnished with the clarifier mechanism. It shall be arranged to have the surface scum swept along an angled skimmer blade to the skimmer assembly, attached at the end of the blade, for discharge to the scum collection trough as shown on the plans. The surface of the clarifier shall be swept twice per revolution.
- B. The skimmer blade shall be tangential to the rotating feedwell and be supported by supports from the feedwell. The skimmer assembly shall be a pivoting aluminum skimmer device. The skimmer shall have replaceable neoprene rubber wipers on all three sides to form a pocket to trap the scum and discharge the scum into the scum box.
- C. The 3'-0" wide scum box shall be directly supported and cantilevered from the tank wall without external supports. The trough shall have a low profile to allow for maximum launder sweeping with the SEL™ Sweeper. The scum trough shall penetrate the tank wall and discharge outside the tank wall. The discharge shall be connected to a six (6) inch scum line, as shown on the contract drawings.
- E. The clarifier equipment manufacturer shall furnish a flush valve assembly for automatic flushing of the scum box and scum pipe. The flush valve assembly shall allow approximately 2 to 5 gallons of clarified effluent to enter the box as the skimmer assembly passes over the scum box. It shall consist of an actuator bar and a pivoting assembly that will open a valve. A counterweight shall close the valve after the flush cycle ends.

2.12 FLOW CONTROL SLIDE GATE

- A. The 304 SS slide gate shall be manufactured by Orbinox, model MU, which is a 4-sided sealing slide gate. Or engineer approved equal.

2.13 SLIDE GATE ACTUATOR

- A. The slide gate actuator shall be manufactured by Rotork, model IQM (Modulating), or engineer approved equal. The actuator shall have the following characteristics: 4-20mA input/output, 3 phase, 60 Hz power supply, IP 68 watertight enclosure, local integral controls, LCD display.

- B. The actuator shall be lubricated in strict accordance with the equipment's operation and maintenance instructions. The required lubricants shall be provided by the contractor.

2.14 LIQUID LEVEL SENSOR

- A. The liquid level sensors shall be manufactured by Endress+Hauser, model number FMR20-1RU0/0. Or engineer approved equal.

2.15 CONTROL PANEL

A. General

- a. The control panel shall be assembled and tested at a Underwriters Laboratory recognized panel shop
- b. Control panel shall be UL508A listed, and shall bear a serialized UL label
- c. A 120 Volt 60 Hz 15 amp supply shall power the control panel.
- d. A ground lug shall be installed in the panel

B. Enclosure

- a. The enclosure shall be NEMA 4X stainless steel.
- b. Operator controls and interface shall be mounted on an internal swingout panel to protect them from sun and weather damage.
- c. Thermal Management equipment shall be provided if necessary to keep the internal enclosure temperature to a maximum of 110° F

C. Un-Interruptible Power Supply

- a. An un-interruptible power supply shall allow the control system, operator interface, and Ethernet switch to continue to function through a short power interruption.

D. Programmable Controller

- a. The PLC shall be an Allen Bradley CompactLogix by Rockwell Automation, or engineer approved equal.
- b. The PLC shall contain the necessary number of inputs and outputs for required function plus 20 percent spare

E. Relays

- a. Relays shall be plug-in tube base type
- b. All relays shall have at a minimum two (2) form-C (NO/NC) contacts.
- c. One pair of contacts must be spare and unused
- d. The minimum relay contact rating shall be 10 amps
- e. Relays shall be used to provide dry contact indication to the site SCADA system for the following indications:
 - i. General Alarm
 - ii. Level High High
 - iii. Level High
 - iv. Level Low
 - v. Level Low Low

- f. Contacts used for SCADA indication shall have the normally open terminals wired to terminals for convenient connection to the site SCADA
- F. Surge Suppression
- a. Surge suppressors shall be provided for all analog I/O.
 - b. Surge suppressors shall be din-rail mountable.
 - c. Surge suppressors shall be capable of being disconnected or removed without tools for troubleshooting.
 - d. If surge suppressors are removable, they shall be capable of being removed from their base without interrupting the circuit.
 - e. If the surge suppressor does not have a connection point for the cable shield, a separate PE terminal shall be provided for the shield of each cable. This PE terminal shall automatically ground the shield to the din-rail/panel backplane.
- G. Terminals
- a. Terminals shall be rated for a minimum of 300 V
 - b. Terminals shall be manufactured by one of the following manufacturers
 - i. Allen Bradley
 - ii. Phoenix Contact
 - iii. Weidmuller
 - iv. No Equal
- H. Operator Interface
- a. The operator interface shall be a color touchscreen.
 - b. The minimum operator interface size is 7”
 - c. The operator interface shall be manufactured by Allen Bradley (Rockwell Automation), or engineer approved equal.
 - d. The operator interface shall provide native VNC or Web Access for remote viewing of the display.
 - e. The interface shall include a trend screen that shows historical data for the following data points:
 - i. Level Setpoint
 - ii. Clarifier Level
 - iii. Actuator Position Command
 - iv. Actuator Actual Position
 - f. The historical data from the trend function shall remain after a power cycle.
- I. Control Functions
- a. The control system shall maintain the level in the Clarifier to within 1” of setpoint when influent flow is stable.
 - b. The level setpoint shall be operator selectable.
 - c. The level shall be capable of being controlled either by a step function or PID.
 - d. When the level is controlled by a step function, the control system must recognize the level returning to setpoint and hold the step function to prevent over controlling the level.

- e. The tuning values for both the PID and Step controls shall be settable from the operator interface.
 - f. The control system shall be capable of automatically selecting a level to use from one of two level transmitters. This system shall be capable of detecting an open loop fault and automatically prevent selection of the faulty transmitter.
- J. Alarm Functions
- a. A user settable alarm value shall be provided for each of the following levels:
 - i. High High
 - ii. High
 - iii. Low
 - iv. Low Low
 - b. The user shall be capable of enabling/disabling each level alarm individually
 - c. The user shall have the ability to set a time delay for the activation each alarm to prevent erratic alarm function
 - d. A general alarm shall be provided to indicate an actuator or level transmitter failure
 - e. Each level alarm and the general alarm shall actuate a separate relay to provide a dry contact indication to the site SCADA system
 - f. Any alarm shall turn on a strobe located on the top of the enclosure.

2.16 PAINTING AND SURFACE PREPARATION.

- A. All non-submerged steel shall be sandblasted to SSPC-SP-6 specifications and given one coat of manufacturer's epoxy primer 2-3 MDFT. All submerged steel shall be sandblasted to SSPC-SP-10 specifications and given one coat of manufacturer's epoxy primer 2-3 MDFT.
- B. Prior to assembly of the drive unit, the castings shall have been sandblasted and thoroughly cleaned to remove any foreign particles in the drive base. After assembly, the drive mechanism shall be solvent cleaned and power wire brushed as needed prior to application of manufacturer's standard primer.
- C. Gear motors shall be furnished with manufacturer's standard enamel.
- D. Coating of the clarifier walls shall be coated with Raven 405 as directed in the drawings.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. The equipment shall be erected in strict accordance with the manufacturer's recommendations. A 2" layer of grout shall be applied to the tank floor in strict

accordance with the manufacturer's recommendations. Screenshot boards shall be supplied by the erecting contractor.

- B. Verify that dimensions are correct and project conditions are suitable for installation. Do not proceed with installation until unsatisfactory conditions have been corrected.
- C. Products installed according to manufacturer's instructions.
- D. Products are to be installed as specified by the manufacturer and as shown in contract documents.
- E. Ensure that products are installed plumb and true, free of warp or twist, within tolerances specified by the manufacturer and as indicated in the contract documents.
- F. Install in accordance with approved shop drawings and in true and proper alignment.
- G. When necessary to adjust lengths of plates due to field conditions and when approved by the Engineer, seal cut or machined edges thus exposed with the manufacturer supplied sealant. Excessive cutting will not be acceptable.

3.02 SERVICE.

- A. The equipment manufacturer shall provide a service representative properly trained in inspection and operation of the mechanism to approve the installation, certify that the torque settings of the drive overload protection device are correct, set liquid level set point and control settings for the SEL™ control system, perform the torque test and instruct the owner's personnel on maintenance and operation. This service shall be in the form of four (4) trips to the site and six (6), eight (8) hour days of service. If additional service is required due to the mechanisms not being fully operational at the time of service requested by the contractor, the additional service days will be at the contractor's expense.

END OF SECTION

SECTION 465361
AERATION BASIN

PART 1 GENERAL

1.01 DESCRIPTION

- A. The work in this section consists of supplying and installing the following BNR Aeration Basin System equipment:
1. Two (2) 20 horsepower low speed, fixed, mechanical surface aerators. Each aerator shall consist of a drive motor, gear reducer, coupling, shaft, surface impeller, a submerged radial pumping impeller and appurtenances, including the Velocity Enhancer.
 2. Two (2) 3.2 horsepower submersible, mechanical mixers for installation in the Anoxic zone(s). Each mixer shall consist of a drive motor, gear reducer, impeller, guide rail and manual lifting hoist assembly.
 3. One (1) each, internal recycle (IR) flow control gate. Each gate shall consist of a drive motor, gear reducer, stand, shaft and gate assembly.
 4. One MCP with two mixer starters, two VFDs and the Control System consisting of monitoring for each D.O.& ORP loop and control logic for the BNR basin process.
- B. All the equipment specified under this Section shall be furnished by a single Manufacturer (the Aeration Equipment Manufacturer) fully experienced, reputable, and qualified in the manufacture of the equipment specified. The basin has been designed to accommodate equipment supplied by Ovivo or approved equal.

1.02 REFERENCES

- A. American Gear Manufacturers Association (AGMA)
- B. National Electrical Manufacturers Association (NEMA)
- C. American Federation of Bearing Manufacturers Association (AFBMA)
- D. American Society for Testing and Materials (ASTM)
- E. American Welding Society (AWS)
- F. Steel Structures Painting Council, American National Standards Institute (SSPC)

1.03 SUBMITTALS

- A. Shop drawing submittals shall include at least the following:
1. Certified shop and erection drawings showing all important details of construction dimensions, anchor bolt locations, aerator impeller

diameter, aerator impeller rotational speed (rpm), aerator impeller tip speed (fps), and field connections.

2. Descriptive literature, bulletins, and catalogs of the equipment, including details of the dry well and gear reducer lubrication points.
 3. Installation, operation, and start-up procedures including lubrication requirements.
 4. Complete motor data.
 5. Total weight of the equipment including the weight of the single largest item.
 6. A complete bill of materials for all equipment with the O&M manual. No samples will be required.
 7. A list of spare parts that are supplied with the project.
 8. Oxygen transfer efficiency test reports from a minimum of two separate U. S. installations per 1.03.B.
 9. Written certification from the aerator manufacturer that the proposed aerators are guaranteed to meet the specified velocity requirements. Shop drawings will not be reviewed without this certification.
 10. Installation list of five operating oxidation ditch applications, including the approved submittal mechanical drawings and control system P&IDs from those projects where the Manufacturer provided aerators, automated internal recycle gate, DO and OPR probes, and associated controls for each. Submittals will not be reviewed without compliance with this requirement.
- B. Aeration Equipment Manufacturer must have experience providing process equipment and control systems applicable to this project. The Aeration Equipment Manufacturer must submit the following information and meet the experience requirements specified below.
1. Test reports (different sites) from two full-scale oxygen transfer tests in oxidation ditches with aerators of similar size installed. If the Aeration Equipment Manufacturer cannot supply a test report for a dual impeller aerator in a full-scale oxidation ditch the Aeration Equipment Manufacturer must supply surface impeller-only aerators with in-channel submersible mixers for this project per paragraph 1.03 C. The Manufacturer must still provide two test reports on surface impeller-only aerators per items b thru d below.
 - a. At least one test shall be from an installation that has a dual impeller aerator of the same make (number of blades, impeller design).

- b. Results from aerators in square tanks or other facilities which are not full-scale operating oxidation ditches are not acceptable.
 - c. Test results must be in U.S. standard units of 1 atm, 20 C, alpha=1.0, beta=1.0, DO=0. Temperature shall be corrected with an Arrhenius coefficient of 1.024 and alpha and beta shall be measured on site if the test was performed using dirty water test methods.
 - d. Minimum standard oxygen transfer efficiency of the surface impeller shall be 3.5 lbs O₂ per motor HP hour. Motor cut sheets shall be included to document efficiency used to convert wire to motor HP.
- C. Only impeller types which have been tested and certified by the independent consulting firm, DHV (the inventors of vertical shaft oxidation ditches), are allowed on this project. There are currently eight (8) impeller types which have been approved by DHV. A letter from DHV stating that the impeller type has been approved for use in oxidation ditch systems shall be submitted by the Contractor. This certification will not require a separate license fee.

1.04 OPERATION AND MAINTENANCE MANUALS

- A. Submit operations and maintenance manuals for the equipment in compliance with the Contract documents, 30 days prior to shipment. Manuals shall include:
- 1. Name, address, and telephone number of the nearest competent service representative who can furnish parts and technical service.
 - 2. Descriptive literature, including illustrations, covering the operational features of the equipment, specific for the particular installation, with all inapplicable information omitted or marked out.
 - 3. Operating, maintenance and troubleshooting information.
 - 4. Complete maintenance parts list.
 - 5. Complete connection, interconnecting and assembly diagrams.
 - 6. Approved Shop Drawings.

1.05 STORAGE AND HANDLING OF EQUIPMENT

- A. The Contractor shall store and temporarily support equipment prior to installation in strict accordance with the Manufacturer's recommendations and instructions. Protect all exposed surfaces. Keep records of the storage parameters and the dates that storage procedures were performed. The Contractor shall be responsible for work, equipment, and materials until inspected, tested and finally accepted.

- B. Store gear reducers and motors in buildings or trailers which have a concrete or wooden floor, a roof and fully closed walls on all sides. Protect the equipment from being contaminated by dust, dirt, vibration and moisture.
- C. Temporarily connect equipment with built in space heaters (connected to a power source) and keep heaters in operation during long-term storage. Rotate all shafts that have bearings in them at least once a month prior to startup. Failure to rotate bearing assemblies will void manufacturers warranty.
- D. Fabricated assemblies shall be shipped in the largest sections permitted by carrier regulations and shall be properly match-marked for ease of field erection. The units shall be erected and lubricated in strict accordance with the instructions of the Manufacturer's field engineer.

PART 2 PRODUCTS

2.01 AERATOR DESIGN AND PERFORMANCE

- A. Performance:
 - 1. The surface impeller of the dual impeller aerator shall be capable of delivering an oxygen transfer efficiency of no less than 3.6 lb. O₂/HP-hr based on motor output power at standard transfer conditions.
 - 2. The aeration equipment must be capable of effectively mixing the basin during basin dewatering until the water level in the basin is reduced to a depth of 2.5 feet. If this requirement cannot be met with the aeration equipment, In-channel submersible mixers must be included in the equipment manufacturer's scope of supply supplied per paragraph 1.03 C.

2.02 AERATOR MOTORS

- A. Each aerator shall be driven by a single speed 20 HP, totally enclosed fan cooled, constant torque, premium efficiency motor wired for 460 volt, 60 cycle, 3 phase current and suitable for VFD application with a 2:1 speed turndown. The motors shall be rated at 40°C ambient with Class F insulation and shall have a Class B temperature rise at full load. The motor shall have a service factor of 1.15 on sine wave power and a 1.0 service factor on VFD supplied power and shall comply with the applicable provision of the Standards of NEMA. The minimum AFBMA B10 bearing life shall be 200,000 hours. The nominal motor speed shall be 1800 rpm.
- B. The motors shall be cast iron construction, Mill & Chemical or Corro- duty, and shall flange mount to the gear reducer. They shall be mounted in a vertical position to the gear reducer and furnished with a canopy cap (drip cover) and suitable lifting lugs. The motor to gear reducer connection shall be accomplished by the use of a flexible coupling.
- C. Motors shall be suitable for operation in a moisture-laden atmosphere. The conduit boxes shall be gasketed with neoprene or equivalent material, so as to prevent moisture from entering the stator through the conduit box. Stainless

steel condensation drains shall be suitably positioned in the lower external surface, so that any accumulation of moisture can drain from the complete motor housing. Ball bearings shall be supplied and shall be grease-lubricated. Grease reservoirs shall be ample and provisions shall be made for re greasing with a lubrication system where grease is flushed through the bearings. The winding end turns shall be dipped and baked with a non-hygroscopic varnish, the stator bores and rotor cores shall be coated with epoxy paint. The entire enclosure shall be finish painted by the motor manufacturer at the factory with a corrosion-resistant paint to provide additional protection against moisture and contaminants. The nameplates shall be stainless steel.

- D. Each motor shall be equipped with a suitably sized space heater to keep condensation from forming when the motor is not running.
- E. Each motor shall be equipped with a normally closed thermostatic heat protection device to protect the motor from overheating during operation. The unit shall immediately stop the aerator drive motor in the event of excessive heat buildup.

2.03 AERATOR GEAR REDUCERS

- A. Each gear reducer shall be of the helical gear type and shall be sized with a minimum service factor for all components of the reducer of at least 2.0 times the motor nameplate horsepower rating in accordance with applicable American Gear Manufacturers' Association (AGMA) standards 2001-C95 errata June 28, 1990, when each unit is operating at full load motor horsepower, 24 hours a day continuous running under moderate shock loads. The efficiency shall not be less than 94 percent based on the gear reducer input horsepower. The gear reducer shall be specifically designed for the loading associated with aerators and/or mixers and shall have an independent lower bearing. The bearing shall be external to the gear box housing to accommodate an oversized shaft/bearing assembly capable of handling external axial and radial forces associated with the longer overhung loads.
- B. The gear reducers shall be designed for vertical input and output shaft operation and the housing shall be cast iron construction with provisions for the attachment of suitable lifting devices. Each reduction unit shall have gearing of the helical gear type. Worm gearing will not be acceptable. The units shall be designed to AGMA Service Classification III. All shafts shall be supported on tapered roller or double spherical roller bearings. Gears and pinions shall be made of alloy steels. Shafting shall be made out of medium carbon steel. The gear teeth shall be through-hardened or carburized. Flame hardened gears will not be acceptable. All gears shall be made from alloy steels with sufficient hardenability to obtain case and core properties meeting the requirements for grade 2 material in accordance with ANSI/AGMA 2001-C95. The steel alloy shall be selected, and the heat treatment shall be controlled, to obtain a microstructure that meets all the requirements for grade 2 material in accordance with ANSI/AGMA 2001-C95.
- C. All gears shall meet the accuracy requirements for AGMA quality No. Q12 in accordance with ANSI/AGMA 2001-B88. Pitting resistance and bending fatigue resistance shall be rated in accordance with ANSI/AGMA 2001-B88.

- D. All bearings incorporated within the gear reduction unit shall have a rating-life expectancy (B10) of 100,000 hours rating-life expectancy (B10), except those bearings attached directly to the output shaft which shall have a rating of 250,000 hours. All bearings shall be of the anti-friction type. Bearing life shall be rated in accordance with ANSI/AFBMA Std. 11-1990 based on operating continuously at the rated full load horsepower and speed.
- E. The lubrication of the speed reducer shall conform to AGMA 9005-E02. A reliable lubrication system shall be provided for the gears and bearings. Lubrication systems which rely wholly or in part upon an oil circulating pump shall incorporate a proven reliable pressure device which will immediately stop the driving motor and transmit an alarm signal to the motor control center in the event of insufficient lubrication. Each electrical switch shall be wired to its respective aerator motor control panel. External oil cooling will not be permitted. The unit shall be provided with a dipstick or sight glass to observe oil levels. Oil fill and drain lines shall be sufficient size to permit efficient functioning and shall be located on the gear unit in a position which is easily accessible from the bridge platform. The oil drain piping shall be installed so that a container may be placed under the drain discharge.
1. The CONTRACTOR shall supply the first charge of run in oil for the reducers, and if necessary due to run time, the change of oil. The CONTRACTOR shall purchase the oil from a local firm selected by the OWNER, in accordance with the information in the Operation & Maintenance manual, to assure lubricant compatibility.
- F. All grease lubricated bearings shall have seals to retain the grease. The low-speed shaft shall have grease lubricated bearings and shall have a dry well to prevent oil leakage. The dry well shall be 100% maintenance free with no wearing parts. The dry well shall be sealed by a non-contact double labyrinth seal with a return drain above. Additionally, the output end of the well shall include the upper and lower bearing seals and separate oil seal. All grease lubrication pressure lines shall be fed from fittings accessibly located above the platform supporting the mechanism.
- G. The housing shall be constructed of high tensile strength gray cast-iron conforming to ASTM A48 class 30 minimum with integral dry well construction to eliminate oil leakage at the output shaft and prevent loss of lubrication in the event of a seal failure. The housing shall be stressed relieved prior to machining. The housing shall be tested to preclude casting porosity or weld defects that could result in oil leakage. Lifting lugs shall be provided on the housing suitably located to enable safe removal of the combined electric motor and gear unit from the supporting platform. Removable inspection cover(s) or inspection port(s) shall be provided.
- H. Each gear reducer shall be mounted on a support with hot dipped galvanized steel bolts. The support shall be mounted on four (4) zinc plated jack studs inserted in the platform structure and designed to withstand all normal operating loads. The jack studs shall have the capability to provide a total vertical adjustment of six (6) inches. The jack stud nuts shall be drilled and tapped with set screws and vibration isolation pads and stainless steel washers shall be provided.

- I. Each gear reducer shall be equipped with a suitable oil immersion-type heater for pre-heating the lubrication oil prior to start up after prolonged periods of shut-down in cold weather. The heaters shall have an automatic thermostatic control and shall operate on the control voltage.

2.04 AERATOR SHOP TESTS

- A. The motor and gear reducer assembly shall be trial fit at the factory and match marked for ease of onsite installation. The high-speed coupling halves shall be factory mounted and aligned. The CONTRACTOR shall be responsible for assuring proper alignment and gap tolerance as set forth in the installation instructions.
- B. The gear reducer shall be run under no load conditions at full speed until the oil temperature has stabilized. The overall lubricant temperature, pressure and sound pressure level shall be recorded during steady-state operation.
- C. After successful completion of the shop test and while the gear reducer is at operating temperature, the lubricant shall be drained and the gear reducer shall be flushed with filtered oil. The flushing oil shall be drained and the gear reducer shall be prepared for shipment.

2.05 AERATOR IMPELLERS, SHAFTS AND COUPLINGS

- A. The surface impeller shall be of a design approved by DHV for use in oxidation ditch systems and shall provide oxygenation and propulsion of the mixed liquor in the oxidation ditch.
- B. The impeller assembly shall consist of a surface and submerged impeller connected to a common aerator shaft as covered under US Patent No. 4,869,818. The surface impeller shall provide oxygenation and propulsion of the mixed liquor in the oxidation ditch. The submerged radial impeller shall provide additional propulsion of the mixed liquor at the bottom portion of the oxidation ditch. The impeller assembly shall operate at a maximum output speed of 46 rpm. The surface impeller shall present a minimum amount of edge perpendicular to the flow to prevent any attachment of solid materials. If the submerged impeller is not used, submersible in-channel mixers shall be provided.
- C. Each surface impeller shall be a rim-blade type with ten, (10) equally spaced blades and constructed of 1/4" minimum steel plate. The rim plate shall be submerged at all operating conditions, except during basin draining operations, to reduce the effects of variable loading on the aerator support structure and deck. This shall be clearly shown on the submittal drawings. The impeller blades and disc shall be an integral, shop welded unit requiring no field assembly or welding.
- D. Each submerged radial impeller shall consist of radial pumping blades and hub that shall be an integral, shop-welded unit requiring no field assembly or welding. Each submerged radial impeller shall draw no more than 10% of the aerator nameplate horsepower at full speed and immersion.

- E. The submerged radial impeller shall be positioned above the basin floor and partition wall extension as shown on the plans shall be formed from concrete. The velocity enhancer will be constructed out of concrete by CONTRACTOR per dimensions provided by the equipment manufacturer.
- F. The aerator shaft shall be attached to the gear reducer by a rigid, cast iron flange-type coupling. A retainer plate shall be provided for mounting to the end of the gear reducer output shaft to provide protection against disengagement of the coupling from the gear reducer output shaft. The flanges and flange-type coupling shall be assembled with A325 high strength bolts only. Stainless steel fasteners are not acceptable.
- G. All structural steel used in the fabrication of the aerator shall conform to the requirements of "Standard Specifications for Structural Steel" ASTM Specification A 36. All shop welding shall conform to the latest standards of the American Welding Society (AWS). Fabricated assemblies shall be shipped in convenient sections as permitted by carrier installations.

2.06 AERATOR PAINTING

- A. Unless otherwise noted, all ungalvanized fabricated iron and steel surfaces shall receive a shop-cleaned surface preparation equivalent to SSPC-SP-10 immediately prior to shop-priming. Shop-priming shall consist of One (1) coat(s) of Tnemec 161-1211 primer or equal to 3.0 to 5.0 Mils D.F.T. Touch up and finish painting shall not be the responsibility of the equipment manufacturer.
- B. The motors and gear reducers shall receive a minimum shop-cleaned surface preparation equivalent to SSPC-SP-1 immediately prior to shop-priming and finish coating. Shop-priming and finish painting shall consist of a coating that is compatible with a high-quality finish coating that is specifically resistant to chemical, solvent, salt water, and acid environmental conditions. Touch-up painting shall not be the responsibility of the equipment manufacturer.

2.07 AERATOR SPARE PARTS

- A. One (1) oil sensing cutout switch and one (1) flexible motor coupling shall be provided.

2.08 MIXER DESIGN AND PERFORMANCE

- A. The submersible mixers for the System shall be furnished by the aerator manufacturer, and, where possible, shall be of the identical model. Each mixer shall include a motor, gear reduction section, bearings, mechanical seals, stainless steel shafts, A48 class 35 or 40 Cast Iron housing, and machined fits for circular cross section O-rings, non-clogging propeller, designed for mixing raw or processed sewage. Each mixer shall be mounted in the basin and each unit shall have a hoist and rail retrieval system that does not require anyone entering the basin to install or remove the mixer.
- B. The mixer design is based on the performance requirements for the biological nutrient removal system; consideration of the future long-term operational and

maintenance costs to the Owner; minimum pumping rate required per basin; optimization of mixing efficiency (HP/MG) and long-term power use (e.g., geared units required for the anoxic basins); efficiency and hydraulic profile of the polyurethane blade design; and specific features (e.g., silicon carbide mechanical seals, pre-chamber) to protect against moisture intrusion into the unit. No exceptions will be made to these performance requirements as specified in this section.

C. Performance:

1. Anoxic Basin mixer key details.
 - a. Number of mixers required - Two (2)
 - b. 200 rpm (Maximum) propeller speed.
 - c. Maximum Power draw – 1.0 HP
 - d. 40 lbs of thrust, minimum.

2.09 MIXER MOTORS

- A. Each mixer shall be furnished with a squirrel cage, induction motor enclosed in a watertight housing suitable for use and compatible with variable frequency drive systems without special order requirements such as “inverter duty”. The motors shall be furnished with moisture resistant Class F insulation treated to be moisture resistant, NEMA B design, designed for continuous duty and shall be non-overloading throughout the entire mixer range of operation without utilizing the motor service factor. Motors shall be capable of sustaining 15 starts per hour (unlimited starts with VFD) at a minimum ambient temperature of 40°C. Motors shall be capable of uninterrupted operation with a voltage drop of 10%.
- B. The motor rotor and stator, as well as all bearings shall be located in an air-filled chamber that is isolated from the seal chamber. Motor cooling shall be accomplished by submergence in the mixed liquid. Thermal switches shall be furnished to monitor stator temperatures. The stator shall be equipped with two (2) thermal switches, embedded in the end coils of the stator winding. Thermal switches shall automatically de energize the motor when its temperature exceeds a preset limit. The mixer manufacturer's nameplates shall be engraved or stamped on stainless steel and fastened to the motor casing with stainless steel screws or drive pins.
- C. Power and control cables shall be furnished in lengths to run continuously from the mixer to the mixer control panel as shown on the Contract Drawings and as specified herein. Cables shall terminate with conductor sleeves. Cables shall be of the "SO" type and shall conform to industry standards for loads, resistance under submersion against sewage, and be of stranded construction. The power cables entering the motor housing shall prevent the moisture from gaining access to the motor even in the event of complete power or control cable break while under water. The cables shall enter the mixer through a heavy-duty entry assembly that shall be provided with an internal grommet assembly to protect

against tension once secured and must have a strain relief assembly as part of standard construction. The cables for each mixer shall be bundled in 10 ft segments for overall neatness and ease of mixer removal.

2.10 MIXER GEAR REDUCER

- A. The motor shall drive all submersible mixer propellers through a planetary gear reduction drive system. The motor shaft shall be fitted with a gear that uses high efficiency teeth to engage the gear section. The gear system shall be custom matched to allow for propeller speed changes by ordering and installing new gearing. The gear section shall be designed to withstand 100 % lock stress from the propeller without gear or bearing damage. Each gear shall be supplied with precision bearings, which are lubricated by the gear lubricant in the gear chamber. The gear section shall be fitted to the output propeller shafting by the use of a straight spline connection. The gear section design shall be such that with regular oil changes, no further maintenance should be required during the life of the submersible mixer in the installation. Gear oil changes shall be easily made using external stainless steel pipe plugs that are sealed via nylon washers. Standard 80 to 90-weight gear oil either normal or synthetic shall lubricate the gear section.

2.11 MIXER SEALS

- A. Each submersible mixer shall be provided with two separate seal oil chambers. The inner chamber shall be located between the motor and the gear reducer and the outer chamber shall be located between the gear reducer and the propeller.
- B. Each mixer shall be provided with two set(s) of independent mechanical seals running in an oil bath. The sealing system shall require failure of mechanical seals prior to moisture entering the motor.
- C. The two mechanical seals shall be interchangeable from one location to the other and each set shall have solid silicon carbide seal face material on both the stationary and rotating components. The metal components of the mechanical seal case shall be constructed of 316 stainless steel. A moisture sensor probe shall be furnished in the seal oil pre-chamber of each mixer. The sensor shall be wired to the control panel or motor control center and wired to shut down the motor if moisture is sensed.

2.12 MIXER SHOP TEST

- A. Each submersible mixer shall be given a factory test during which the mixer shall be run for a minimum of one-half hour. Tests shall show that the mixer has the general characteristics of amp draw, starting capability, and such other properties as appear on the approved submersible mixer shop drawings without overheating or excessive vibration.
- B. One copy of all test data shall be submitted with the Operation & Maintenance manuals. As a minimum, shop test results shall include the following information:
 - 1. Tests for each submersible mixer showing:

- a. Mechanical and electrical integrity check established by physical inspection and by megger prior to applying power.
- b. Power leads shall be applied and the motor started to verify proper rotation.
- c. Mixer shall be run in the submerged condition to verify amp draw, starting capability, mechanical and electrical integrity.
- d. After running, the unit shall again be checked by megger and by physical inspection.

2.13 MIXER PROPELLER AND SHAFT

- A. Mixer propellers shall be PUR (polyurethane resin) AND/OR stainless steel – that is resistant to chemical effects and provides the highest mixing efficiency due to the blade cross section. Welded steel propellers shall not be accepted. The propeller vanes shall be smooth, finished throughout, and shall be free from sharp edges. The surface of the propeller shall be free from defects and surface protrusions and shall be smooth.
- B. Propellers shall be statically and dynamically balanced after assembly to the rotor. Propellers shall be slip fit and securely held to the shaft by a stainless steel washer and bolt assembly that is enclosed in a separate hub chamber.
- C. The hub chamber is fitted with an O-ringed cap that seals the entrance of the propeller hub chamber device. The output shaft shall be splined to mate with the matching spline insert of stainless steel that forms the hub of the propeller. The arrangement shall be such that the propeller cannot unscrew or be loosened by torque from either forward or reverse rotation. Designs based on threaded connection between mixer shaft and impeller will not be considered.
- D. Mixer shafts shall be series 420 stainless steel with a minimum 1.375” diameter. Shafts shall be supported by bearings for axial and radial thrust and bearing life shall be designed to provide minimum B10 = 100,000 hours at design flow rate. All shafts shall be dynamically balanced and shall be amply sized to minimize shaft deflection. Shaft overhang shall not exceed 2.5 times the shaft diameter where it passes through the mechanical seal area and the overhang shall be the length of the shaft from the propeller side of the last bearing closest to the hub of the propeller.
- E. The engineer reserves the right to require submission of a sample of the output shaft detail drawing details to independently verify submittal calculations. Carbon steel shafts with or without shaft sleeves are not acceptable or equal to stainless steel.

2.14 MIXER MOUNT ASSEMBLY

- A. Each mixer shall be provided with a stainless steel mixer mount assembly to serve as a guide mast for the mixer during installation and to guide the mixer for removal from the liquid for service. The assembly shall consist of a minimum 3 inch by 3 inch tube and an upper and lower bracket constructed of stainless

steel. The assembly shall also contain a stainless steel floor-mounted bracket to support and securely hold the mast assembly and shall allow horizontal rotation of the mast through not less than 120 degrees. The mast bearings shall be constructed of UHMW.

- B. The mast assembly shall be capable of proper operation with the mixer operating in any direction. The mixer mast shall be designed in such a way that the mixer can be lowered onto and off of the mast. The upper guide holder assembly shall secure the system to the top platform/wall and shall provide lateral support for the guide pile and a securing device for the electrical motor cable.
- C. Each mixer shall be provided with a crane assembly permanently located at the top of the basin over each mixer. The boom arm of the mixer shall be designed to properly reach and locate the mixer and to alter the angle of the mixer to assure proper mixing angles. The boom shall include a rotational turning handle and shall be capable of rotating a minimum of 360 degrees within the receiving box by means of a Teflon bearing. Each crane assembly shall include a winch and a minimum 1/4", 316 stainless steel lift cable with proper length to remove and set the mixer on the walkway. The winch assembly shall be capable of manual lift. All anchor bolts for the rail, mast and crane assembly shall be 304 stainless steel.

2.15 MIXER CASING AND COATING

- A. Casings shall be manufactured from ASTM A48 Class 35 or 40 close-grained cast iron. The outside contours of the mixer(s) shall be shaped to reduce hydraulic losses and to aid in mixing efficiency. Each casting shall be free from porosity, voids, casting fins, and other casting quality defects. The surface shall be smooth to the touch and free from all sharp edges and coated with ceramic base coating for chemical and abrasion resistance. Corners shall have smooth radius contours to avoid sharp edged corners and surfaces.
- B. The entire body of the mixer assembly shall be abrasive blasted to SSPC-SP10 with a minimum 2.5 mil profile. The mixer shall then be immediately coated with a minimum of 15 mils of Ceramic compound. The Ceramic compound shall be a two-part polymer/ceramic design for airless spraying, cold-curing, solvent free and include reinforcing with special fillers and extenders. The corrosion resistance below the surface of the coating shall be capable of withstanding ASTM salt spray test for over 3000 hours. Epoxy, enamel coatings or stainless steel sheet covering a cast iron body will not be considered as equal to the specified coating system and will not be accepted.

2.16 MIXER SPARES

- A. The units shall be supplied with the following spare parts:
 - 1. One (1) set of bearings, one (1) set of mechanical seals set, and one (1) set of O-rings.

2.17 FLOW CONTROL GATE DESIGN AND PERFORMANCE

- A. One automated flow control gate shall be furnished per oxidation ditch suitable for installation in the bypass channel as shown on the contract plan drawings. Each mechanism shall be motorized with 90 degree travel
- B. The equipment furnished for each gate mechanism shall include: stand, actuator, rotating shaft, guide bearings, flow vane, fasteners and anchor bolts.
- C. The flow control gate is designed to direct and control the flow from the aeration basin to the upstream anoxic basin.
- D. Except where specifically indicated otherwise, all plates and structural members designated for submerged service shall be 1/4" minimum thickness and reinforced as required. Stainless steel 304 anchor bolts and 304 fasteners with necessary hex nuts and washers shall be provided for all parts of the gate assembly.
- E. Fabricated assemblies shall be shipped fully assembled except for attachment of the actuator, stand, shaft and guide bearings. The unit shall be designed to allow adjustment for concrete tolerances of $\pm 1/2"$. The unit shall be erected and lubricated in strict accordance with instructions from the manufacturer.

2.18 ACTUATOR

- A. The actuator shall consist of an electric motor, worm gear reduction, absolute position encoder, electronic torque sensor, mechanically and electrically interlocked reversing motor contactor, electronic control, protection, and monitoring package, manual override handwheel, valve interface bushing, 32-character graphical Liquid Crystal Display (LCD), and local control switches all contained in an enclosure that is sealed to NEMA 4X. Actuator design life shall be at least one million drive sleeve turns.
- B. The power transmission shall be completely bearing-supported, and consist of a hardened alloy steel worm and bronze alloy worm gear, oil-bath lubricated using a synthetic oil designed specifically for extreme pressure worm and worm gear transmission service.
- C. The motor shall be three-phase / 60-cycle, 460 V with Class F insulation and a thermistor embedded within the motor windings to prevent damage due to overload. The motor shall be easily removed through the use of a plug-in connector and shaft coupling.
- D. Valve position shall be sensed by an optical, absolute position encoder with redundant position. Open and closed positions shall be stored in permanent, nonvolatile memory. The encoder shall measure valve position at all times, including both motor and handwheel operation, with or without power present, and without the use of a battery. The absolute encoder will be capable of resolving $\pm 7^\circ$ of output shaft position over 10,000 output drive rotations.
- E. The reversing contactor shall be mechanically and electrically interlocked to prevent simultaneous energizing of the open and close coils. The control module shall also include an auto reversal delay to inhibit high current surges caused by rapid motor reversals.

- F. Emergency Shut Down (ESD) provision shall be included in each actuator. The actuator shall permit up to three inputs for ESD and they shall be configurable. The ESD signal shall override any existing signal (except LOCAL, STOP, and INHIBIT) and send the valve to its configured emergency position.
- G. Four latched status contacts shall be provided for remote indication of valve position, configured as 1-N/O and 1-N/C for both the open and closed positions. A monitor relay shall be included and shall trip when the actuator is not available for remote operation.
- H. A 32-character, graphical LCD shall be included to display valve position as a percent of open, 0-100%, and current actuator status. A lockable LOCAL-STOP-REMOTE switch and an OPEN-CLOSE switch shall be included for local valve actuator control. The OPEN-CLOSE switch may be configured for maintained or push-to-run (inching) control.
- I. The device shall be non-intrusive - All calibration shall be possible without removing any covers and without the use of any special tools. All calibration shall be performed in clear text languages.
- J. A handwheel and declutch lever shall be provided for manual operation. The handwheel shall not rotate during electric operation nor can a seized motor prevent manual operation
- K. The actuator shall include a removable torque or thrust bushing to mate with the valve shaft.
- L. Factory testing - Every actuator shall be factory tested to verify but not limited to: handwheel operation, local control, control power supply, valve jammed function, motor thermistor, LCD and LED operation, direction of rotation, microprocessor checks, and position-sensor checks..
- M. 4-20 mA signal shall be used for both control and feedback from the actuator.
- N. The actuator shall be fitted to the gate shaft with a sleeve and key for ease of assembly and disassembly.
- O. The actuator shall be supported on a stand that is anchored to the concrete floor or side wall by epoxy type 304 stainless steel anchors. The stand shall be of proper height to allow the operator a convenient grip on the handle for clockwise or counter clockwise turning.

2.19 GATE ROTATING ASSEMBLY

- A. Each gate shall be constructed from 1/4" properly stiffened steel plate. Each gate shall include a revolving flow vane assembly fixed between guide bearings mounted to the floor and stand. The floor bearing shall be a thrust type alignment bearing, supporting the entire weight of the unit. The upper guide bearing shall be an integral part of the support stand and shall be mounted just below the worm gear reducer. The center guide bearing, if required by the shaft length, shall be mounted just above the water surface on the lower part of the

shaft and shall be field aligned after installation of all other components, assuring proper rotational capability.

- B. The revolving shaft shall be supported at each end in such a manner that a slight vertical or horizontal misalignment shall not interfere with the smooth operation of the gate. The shaft shall revolve from the turning of the gear unit.
- C. Each gate shall be designed to operate smoothly under the flow conditions existing in the aeration basin.

2.20 GATE SURFACE PREPARATION AND PAINTING

- A. Unless otherwise noted, all ungalvanized fabricated iron and steel surfaces shall receive a shop-cleaned surface preparation equivalent to SSPC SP 10 immediately prior to shop-priming. Shop-priming shall consist of one (1) coat of Tnemec 161-1211 Epoxoline primer or equal to 3.0 - 5.0 mils DFT. Touch up and finish painting shall not be the responsibility of the equipment manufacturer.
- B. Actuator shall be furnished with manufacturer's standard surface finish.

2.21 SPARE PARTS

- A. NONE RECOMMENDED

2.22 EQUIPMENT CONTROLS

- A. All equipment used to control the BNR Control System shall be supplied by the BNR System manufacturer. This is to keep continuity and single source responsibility for the entire system. Manufacturer to demonstrate experience in accordance with submittal requirements of this specification.
- B. The control system shall be fully compatible and communicate with the SCADA system being installed at this plant, see specification appendix for SCADA specifications.
- C. The controls shall be designed to provide high reliability. The BNR System manufacturer shall provide the programming with logic functions to match the process and operational requirements of the system. The controller shall allow the system to operate the equipment without excessive speed.
- D. The control panel(s) shall be located in a climate controlled building

2.24 CONTROL PANEL

- A. The Control System shall be integrated in a NEMA 12 MCP configuration and shall be installed in a climate controlled building. A 480V, 3 phase, 60 Hz feed is required. Main lugs shall be included. The aerator VFD(s), PLC/HMI controller, and all BNR motor starters shall be integrated into the MCP. A panel board section shall be provided to allow for power distribution to control system instrumentation and BNR motor oil immersion heaters. The PLC control panel and the MCP shall conform to UL508A.

1. Programmable controller (PLC)
 - a. The PLC shall be Allen Bradley CompactLogix 1769-L30ER, with discrete inputs and outputs. The CompactLogix shall be backed by a Compact Flash.
 - b. Discrete input cards shall be rated for 120V and be equipped with 16-points per card.
 - c. Discrete output card shall be relay-type, rated for 120V and be equipped with 16-points per card.
 - d. Analog cards shall be rated 4-20 mA. Each input shall be protected by a surge protection device.
2. Human Machine Interface (HMI)
 - a. The HMI shall be a 15-inch TFT color touch screen, industrial operator interface.
 - b. The HMI shall have one USB port and one Ethernet port.
 - c. The HMI shall be Allen Bradley Panel View Plus
3. Terminal Blocks
 - a. The terminal blocks used in the Control Panel will be as specified in the BNR section and supersedes other terminal block specifications.
 - b. Power Terminals: Unit construction type with closed back tubular pressure screw connectors, rated 600 volts
 - c. Signal and Control Terminals: Modular construction type, suitable for channel mounting, with spring type connectors, rated 300 volts.

E. OPERATION

1. The HMI shall allow the operator the ability to modify the following, but not limited to, setpoints and parameters for the operation of the system:
 - a. MANUAL MODE
 - i. VFD Speed Adjustment
 - ii. Flow control Gate Adjustment
 - b. AUTO MODE - AERATORS

- i. Aerator power input shall be adjusted using VFDs to match process oxygen demands using Dissolved Oxygen (D.O.) concentration as the primary control parameter. The D.O. level will be monitored at the locations shown on the plans.
- ii. Allow selection of PID or Step Control
- iii. Allow input of D.O. setpoints and limits
- iv. Allow selection of DO Probe(s) To Use For Control. (One DO Probe Per Aerator or One DO Probe For Both Aerators)
- v. Allow selection of shutdown mode for each aerator
- vi. Include timers for aerator shutdown to ensure aerators do not shut down for more than an operator set value when not in fault
- vii. Include separate DO Alarm Setpoints With Timers
- viii. Allow disabling Individual DO Alarms (but not equipment alarms)
- ix. Operators shall be allowed to operate one aerator in MANUAL and one in AUTO and control system will operate the aerator in AUTO accordingly.
- x. Proper velocity shall be maintained while running both aerators in AUTO operation.
- xi. The D.O. levels shall have defined limits that shall be user-defined but factory preset on the HMI. The factory set algorithms shall be the responsibility of the aeration system supplier and shall be specifically designed for the installed system.
- xii. The entire system shall be designed to restart after power outage if no alarm conditions are present that would normally shut the unit down.
- xiii. Low oil pressure and high motor temperature shall shut down aerators in both MANUAL and AUTO mode. System shall allow for oil pump pressure delay during startup of aerators.
- xiv. The aerator OFF time shall be monitored and an exercise alarm activated when a unit needs to be operated for warranty purposes.

c. AUTO MODE FLOW CONTROL

- i. The position of gate shall be adjusted based on timers and ORP readings.
 - ii. Operator adjustable setpoints including time of day, target ORP, minimum and maximum settings shall be included
 - iii. Allow selection of PID or Step Control
- 2. The Control System shall allow sufficiently stable basin DO, ORP, and level to meet stated process requirements.
- 3. The HMI shall provide to the operator the following, but not limited to, monitoring parameters:
 - a. Real time VFD speed(s).
 - b. Real time D.O. level(s).
 - c. Aerator status.
 - d. EliminatIR gate position
 - e. Real time ORP level(s)
 - f. Mixer status
- 4. HMI shall include a 48-hour trend graphs which include DO/ORP/level setpoints, real time DO/ORP/level, aerator speeds, all gate/weir positions.
- 5. The HMI shall have HELP screens that clearly explain all critical setpoints and operational modes.

F. INSTRUMENTATION

- 1. Analyzer
 - a. The Analyzer shall be a microprocessor based instrument. Connections between the probe sensor and the controller shall be “plug-and-play” without requiring extensive programming or configuration. The system shall be able to perform automatic calibration of the dissolved oxygen monitoring system.
 - b. The controller shall have wireless downloading capability through an IR port located on the controller unit to download and print real time data, calibration history and current set points in a CSV format.
 - c. The controller unit shall allow control of the sensor and interface functions using menu driven software. The interface unit shall have a built-in data logger with the capacity to store data on 15-

minute intervals for up to 6 months. The display for the unit shall be a graphic dot matrix LCD display, 128 x 64 pixels with LED backlighting. All user settings for the controller shall be retained indefinitely in non-volatile memory (EEPROM)

- d. The controller unit shall include two analog 4 to 20mA output signals proportional to dissolved oxygen level and temperature, and shall include two independent PID control functions including high/low phasing, setpoints, dead bands, off delay and on delay.
 - e. The unit shall include three (3) SPDT, user configurable Form 'C' alarm contacts, rated at 100 to 230 volts AC, 5 amp resistive maximum. The unit shall be capable of providing the following alarm conditions: low alarm setpoint, low alarm point dead band, high alarm setpoint, high alarm point dead band, off delay and on delay.
 - f. The controller unit shall be housed in a NEMA 4X enclosure with a corrosion resistant finish. The AC power supply to the unit shall be housed in the interface unit and shall automatically accept input in the range of 100 to 230 volts AC, single phase, 60 Hz. The interface unit shall be supplied with a sun shield. The unit shall be capable of exterior mounting, vertically on the handrail.
 - g. The Controller shall be HACH Model SC 200 Controller as manufactured by the Hach Company.
2. Dissolved Oxygen Probe (2 per train):
- a. The Dissolved Oxygen (D.O.) Probe shall be a continuous reading probe that utilizes luminescent sensor technology.
 - b. The probe material shall be foamed Noryl® and Type 316 stainless steel. All parts of the probe shall be corrosion resistant and fully immersible. The D.O. sensor material shall be polybutyl methoacrolate.
 - c. The measurement range of the probe shall be 0.00 to 20.00 mg/L dissolved oxygen and 32.0 to 212.0° F (0.0 to 100.0° C) temperature. The operation of the probe/analyzer shall not be affected by H₂S, pH, metals and salts normally found in domestic wastewater. The probe shall provide for electrolyte-free operation without the requirements of sample conditioning.
 - d. The probe shall not require periodic membrane changing. The sensor cap shall be easily replaceable and cleaning accomplished by periodically wiping the sensor with a clean rag. The accuracy of the sensor shall be ±0.1 mg/L for levels less than 1.0 mg/L and ±0.2 mg/L for D.O. levels greater than 1.0 mg/L. The sensitivity of the probe shall be ±0.5% of the span and the

repeatability of the probe shall be $\pm 0.5\%$ of the span. The response time of the probe shall be 1 to 60 seconds to 90 percent of the value upon a step change in D.O.

- e. The D.O. probe shall be the HACH LD.O.® Probe for dissolved oxygen and temperature measurement as manufactured by the Hach Company.

3. ORP Probe (1 per train)

- a. The ORP sensor shall be of Differential Electrode Technique design using two measuring electrodes to compare the process value to a stable internal reference standard buffer solution. The standard electrode shall have non-flowing and fouling-resistant characteristics.
- b. The sensor shall have a hex-shaped body to facilitate mounting, and shall be constructed of Ryton® material for exceptional chemical resistance and mechanical strength. This material shall enable the sensor to be installed in metal fittings without leakage usually caused by heating and cooling cycles when dissimilar materials are threaded together.
- c. The sensor shall have a convertible body style featuring 1-inch NPT threads on both ends to mount into a standard 1-inch pipe tee, into an adapter pipe for union mounting with a standard 1-1/2 inch tee, or onto the end of a pipe for immersion into a vessel.
- d. The built-in electronics of the sensor shall be completely encapsulated for protection from moisture and humidity.
- e. The sensor shall have a built-in preamplifier to enable the signal to be transmitted up to 100 m (328 ft.) with standard cabling and up to 1000 m (3280 ft.) with a termination box.
- f. The ORP sensor shall include a titanium ground electrode (standard) to eliminate ground loop currents in the measuring electrodes.
- g. The ORP sensor shall be Hach Ryton ORP measurement sensor as manufactured by the Hach Company

G. Probe Mounting:

1. D.O. / ORP Probe

- a. The Probe(s) shall be provided with a mounting system capable of being attached to hand railing. The Probe(s) shall be attached to an arm that is suspended in the basin. The arm shall be manufactured of Schedule 80 PVC pipe and fittings and furnished by the installing contractor.

- b. The swivel bracket that attaches the arm to the hand railing shall be fabricated of Type 316 stainless steel. All nuts, bolts, washers and other hardware used to mount the pole to the swivel bracket and to mount the bracket to the hand railing, shall be furnished.
- c. The Probe mounting bracket shall be constructed to allow for easy calibration or exchange of the Probe without the use of tools.

H. Mixer Motor Starters:

- 1. This specification is for the BNR system equipment and shall supersede all other motor starter specifications relating to the aeration mixers equipment.
- 2. Mixer motor starter shall be NEMA rated with electronic overload relays. The overload relays shall provide critical motor protective functions for the following:
 - a. Thermal overload
 - b. Phase loss
 - c. Ground fault
 - d. Stall / Jam
 - e. Underload
 - f. PTC thermistor monitoring
 - g. Current imbalance
- 3. Mixer motor overload relays shall perform true RMS current sensing and shall include integrated I/O. The overload relays shall include diagnostic functions for the following:
 - a. Motor diagnostics
 - b. Preventative maintenance diagnostics
 - c. Motor current monitoring
- 4. The electric overload relays shall have EtherNet communications included. The overload relays shall be Allen Bradley bulletin 193/592 E300 with current sensing module and Ethernet communications or equivalent.
- 5. Each shall have a Diagnostic Starter station mounted on the cabinet door.
- 6. Auxiliary Relays
 - a. Provide relays for General Fault, Mixer Fault, Mixer Run, and Safeties, and Enable (as required).

- b. The control relays shall be rated for 115V AC/30V DC, and at least 5.0 amp resistive, 2.5 amp inductive.

I. VARIABLE FREQUENCY DRIVES

1. This specification is for the BNR system equipment and shall supersede all other VFD specifications.
2. The Variable Frequency Drive (VFD) system shall contain all components required to meet the performance, protection, safety and certification criteria of this specification.
3. The VFD(s) shall be located in the electrical room in a climate controlled building.
4. The VFD(s) shall allow for internal monitoring and control of specific BNR aeration equipment. These signals shall include but not limited to:
 - a. Oil pressure monitoring
 - b. Motor thermal overload monitoring
5. The VFD(s) shall be 6-pulse.
6. Hardware
 - a. Utilize diode bridge or SCR bridge on the input rectifier.
 - b. Utilize switching logic power supply operating from the DC bus.
 - c. Incorporate phase to phase and phase to ground MOV protection on the AC input line.
 - d. Microprocessor based inverter logic shall be isolated from power circuits.
 - e. Utilize latest generation IGBT inverter section.
 - f. Inverter section shall not require commutation capacitors.
 - g. Ethernet port for direct network cable connections.
 - h. Battery receptacle for Lithium battery power to the Real Time Clock.
 - i. Additional DPI port for handheld and remote HIM options.
 - j. Dedicated Digital Input for hardware enable.
 - k. Optional onboard 24V DC Auxiliary Control Power Supply

7. Control Logic
 - a. Ability to operate with motor disconnected.
 - b. Provide a controlled shut down, when properly protected, with no component failure in the event of an output phase to phase or phase to ground short circuit. Provide annunciation of the fault condition.
8. Power Conditioning
 - a. Designed to operate on an AC line which may contain line notching and up to 10% of voltage harmonic distortion.
 - b. An input isolation transformer shall not be required for protection from normal line transients.
9. Current Limit
 - a. Programmable current limit.
 - b. Current limit shall be active for all drive states: accelerating, constant speed and decelerating.
 - c. The drive shall employ PI regulation with an adjustable gain for smooth transition in and out of current limit.
10. Flying Start
 - a. The drive shall be capable of determining the speed and direction of a spinning motor and adjust its output to "pick-up" the motor at the rotating speed.
11. Inputs and Outputs
 - a. The Input / Output option modules shall consist of both analog and digital I/O.
 - b. No jumpers or switches shall be required to configure digital inputs and outputs.
 - c. All digital input and output functions shall be fully programmable.
 - d. The control terminals shall be rated for 115V AC.
 - e. Inputs shall be optically isolated from the drive control logic.

- f. The control interface card shall provide input terminals for access to fixed drive functions that include start, stop, external fault, speed, and enable.
12. Ratings
- a. Voltage
 - i. Capable of accepting nominal plant power of 480V AC at 60Hz.
 - ii. The supply input voltage tolerance shall be $\pm 10\%$ of nominal line voltage.
 - b. Displacement Power Factor
 - i. Capable of maintaining a minimum true power factor (Displacement P.F. X Distortion P.F.) of .95, lagging, over the entire speed range.
 - c. Efficiency
 - i. A minimum of 96.5% (+/- 1%) at 100% speed and 100% motor load at nominal line voltage.
 - ii. Control power supplies, control circuits, and cooling fans shall be included in all loss calculations.
 - d. Operating ambient temperature range without derating: 0 °C to 40 °C (32 °F to 104 °F)
 - e. Operating relative humidity range shall be 5% to 95% non-condensing.
 - f. Operating elevation shall be up to 1000 Meters (3,300ft) without derating.
13. The VFD shall be rated at Heavy Duty loads and shall provide 150% overload capability for up to one minute and 180% for up to 3 seconds.
14. Communications
- a. VFD shall provide an EtherNet/IP port.
15. Enclosure Door Mounted Human Interface Module (HIM)
- a. VFD shall provide a HIM with integral display, operating keys and programming keys.
 - b. The HIM shall be rated NEMA/ UL Type 4/12 panel mounting that is connected via cable.

- c. The display portion shall have the following features:
 - i. The display shall show drive operating conditions, adjustments and fault indications.
 - ii. The Human Interface shall provide digital speed control.
 - iii. The keypad shall include programming keys, drive operating keys (Start, Stop, Direction, Jog and Speed Control), and numeric keys for direct entry.
16. Enclosure
- a. Shall be rated UL Type (12).
 - b. Shall be painted per the manufacturer's standard.
 - c. Shall provide entry and exit locations for power cables.
 - d. Shall contain a label for UL508.
 - e. The drive system nameplate shall be stamped with SCCR ratings inside the enclosure.
17. Drive Input Disconnect
- a. VFD shall provide a door interlocked fused disconnect switch
 - b. Operator Handles
 - i. Provide externally operated handles for disconnects.
 - ii. Handles shall be lockable.
18. Control Power Transformer
- a. Provide a control power transformer mounted and wired inside of the drive system enclosure.
 - b. The transformer shall be rated for the VFD power requirements.
19. Auxiliary Relays
- a. Provide relays for Drive Alarm, Drive Fault, Drive Run, and System Status Faults (as required).
 - b. The relay contacts shall be rated for 115V AC/30V DC, 5.0 amp resistive, 2.5 amp inductive.
20. Control Interface
- a. The control terminals shall be rated for 115V AC.

- b. Inputs shall be optically isolated from the drive control logic.
- c. The control interface card shall provide input terminals for access to fixed drive functions that include start, stop, external fault, speed, and enable.

21. Motor Heater Control

- a. The drive system shall provide the drive control circuitry to energize an existing motor heater whenever the motor is not running.
- b. The heater control shall be interlocked with the drive and/or bypass and shall be energized whenever the motor is not running.

PART 3 START UP BY MANUFACTURER

3.01 The Manufacturer of the mechanical surface aerators shall furnish the services of a factory representative who has complete knowledge of proper operating and maintenance to inspect the final installation and supervise a test run of the equipment. The Manufacturer shall furnish a minimum of 2 separate trips and a minimum of 4 days total on-site service.

- A. The test runs on the mechanical aerators shall be undertaken with water in the aeration tanks filled up to the high water elevation shown on the Drawings. The Contractor shall be responsible for providing sufficient water, or treated wastewater for filling the tanks for the test runs on the aerators. The test runs on the aerators shall confirm acceptable normal running noise, speed and direction.
- B. After the aerator is installed and aligned, and the manufacturer's recommendations for initial start up have been implemented, the aerator shall be run at full speed and full load for a minimum of two hours after the oil temperature has stabilized. The gear reducer housing and shaft seals shall be checked for leakage of lubricant. Any leaks shall be corrected and the temperature rise of the lubricant in the oil sump of the gear reducer shall not exceed 100°F above ambient.
- C. In the event of improper installation, the Contractor and the manufacturer shall be responsible for supervising the correction of the work and subsequent test runs until the defects are corrected.

PART 4 WARRANTY

4.01 WARRANTY

- A. The equipment supplier shall warrant that its equipment shall be free from defects in material and workmanship; and that it will replace or repair, F.O.B.

its factory, any part or parts returned to it which examination shall show to have failed under normal use and service by the user within eighteen (18) months following initial shipment or twelve (12) months following operation start up, whichever occurs first.

END OF SECTION

SECTION 467320

FLOATING AERATOR – AEROBIC DIGESTER

1. GENERAL

Furnish two (2) - 2 HP floating aerators. Each aerator shall consist of a motor, a direct drive impeller driven at a constant speed and an integral flotation unit.

2. AERATOR DRIVE MOTOR

- 2.1 The motor shall deliver 2 horsepower and shall be wired for 460 volt, 60 cycle, 3 phase service.
- 2.2 The motor shall be totally enclosed; fan cooled, and generally rated for severe chemical duty, and shall have a 1.15 service factor.
- 2.3 The motor windings shall be non-hygroscopic, and insulation shall equal or exceed NEMA Class "F".
- 2.4 A condensate drain shall be located at the lowest point in the lower end-bell housing.
- 2.5 All motor frame parting surfaces shall be deep registered and Permatex (or equal) sealed.
- 2.6 All through bolts, nuts, and screws shall be of type 18-8 stainless steel.
- 2.7 Each motor will have a raincap constructed of cast iron or non-corrosive 304 stainless steel. Painted or plated carbon steel rain caps will not be acceptable.
- 2.8 A stainless steel nameplate shall be provided with each motor and shall be securely fastened thereto. The voltage, speed, insulation class, amperage, service factor, wiring diagram, motor serial number, and the manufacturer's name and address shall be steel stamped or otherwise permanently marked.

3. MOTOR SHAFT

Unit shall have a one-piece motor shaft continuous from the top motor bearing, through the lower bearing and down to and through the propeller. This shaft will have a minimum diameter of 2-1/2 " and be manufactured from 17-4 PH stainless steel, or comparable stainless steel having a minimum yield strength of 100,000 psi on units 2 HP and larger.

4. RPM

Units shall operate at the lowest RPM offered in this size by the manufacturer. In no case shall nominal RPM exceed 1800 for units meeting the one-piece shaft specified above. Units featuring one-piece shaft shall operate nominally at 1800 RPM in the size range of 3 - 15 HP, or at a nominal maximum speed of 1200 RPM for units in the 20 - 75 HP size range.

5. MOTOR BEARING

5.1 Motor bearings shall be regreasable. Sealed bearings are not acceptable. Top bearing shall be shielded on the bottom side only. Bottom bearing shall be open.

5.2 The top and bottom motor bearings shall be of the combined radial and axial thrust type and shall be packed at the factory with a "high performance" grease.

5.3 The lower motor bearing inner race shall be locked to the motor shaft via a special washer and locking nut arrangement. The shaft shall be threaded just below the lower bearing and shall have a keyway cut into the motor shaft. This key shall accept a tab from the I.D. of the locking washer, and the locking nut shall have recesses to accept a tab from the O.D. of the locking washer to prevent the nut from backing off. Snap ring type bearing retainers will not be acceptable.

6. DIFFUSION HEAD

6.1 The design of the diffusion head shall be such that the liquid spray will discharge at angle of 90° to the motor shaft, and over a 360° pattern in the horizontal plane, and shall be a stainless steel monolithic casting.

6.2 The diffusion head casting shall act as a base for the aerator motor, and alignment of the motor to this base shall be controlled by machined index fittings that engage the P-base of the motor. Diffusion head/motor arrangements that are dependent upon boltholes only for alignment will not be acceptable. All diffusion head hardware will be 304 stainless steel and safety wired.

6.3 The diffusion head casting shall act as a thrust block to deflect the high velocity, pumped volume of the aerator from the vertical to the horizontal direction. In order to minimize vibration, and to provide adequate strength, the diffusion head

334 lbs unless manufacturer specifies directly. The bottom side of this casting shall have a 90°-radiused transition to effect the hydraulic change in direction with a minimum of head loss.

- 6.4 The diffusion head shall absorb all normal and shock loads encountered by the propeller and transmitted to the diffusion head via the motor shaft and lower motor end-bell. The diffusion head shall distribute these forces into the float via webs that terminate in a flange or ring that is an integral part of the diffusion head. This flange shall mate with a similar flange that is an integral part of the float/volute to spread the stresses generated by the propeller uniformly around the float so that no point loading of the float is allowed. These flanges shall be machined flat to provide proper bearing surfaces. The alignment of the diffusion head flange to the float/volute shall be by use of a 360° index pilot.
- 6.5 Specifically, diffusion head designs that employ studs and spacers, shoulder bolts or fiberglass are not allowed. Load bearing, machined flat, flange-to-flange connections will be mandatory.
- 6.6 The diffusion head shall contain an anti-deflection journal insert to limit the radial deflection of the motor shaft.
- 6.7 This anti-deflection journal insert shall be located in the lower extremity of the diffusion head, approximately one-half the distance between the motor base and the lower end of the shaft.
- 6.8 The journal insert shall be machined from Delrin or molded from moly-filled urethane and shall be a minimum of 0.060" diameter or larger through the bore than the diameter of the motor shaft.
- 6.9 Units featuring a one-piece unsupported shaft will not be acceptable.
- 6.10 There shall be a fluid deflector located on the motor shaft immediately below the anti-deflection journal, which shall cover completely the anti-deflection journal insert and the lower portion of the diffusion head.
- 6.11 This fluid deflector shall be molded from black neoprene and shall be press fit onto the motor shaft.

7. FLOTATION

- 7.1 Each aerator shall have 192 lbs. reserve buoyancy to ensure stability and to provide support flotation required during aerator servicing. Floats shall be one piece, i.e.; segmented floats are not acceptable.
- 7.2 Flotation stability will be mandatory. Under no circumstances will unstable floatation designs requiring counter balancing, ballast of liquid, solid mass or submerged major fabricated assemblies to stabilize the operation of the aerator be allowed. Only aerators demonstrating stable operational characteristics, without rocking or oscillating will be acceptable.
- 7.3 The float shall be a minimum of 46.75" in diameter and 7" thick, and shall be fabricated of approved fiberglass construction as later described herein.
- 7.4 All floats shall be constructed so that the internal void can be filled full of closed cell polyurethane foam having a minimum 2.0 lbs/ft³ density and shall be completely sealed water tight.
- 7.5 All floats shall have six mooring points, spaced for 3 or 4-point mooring around the outer circumference. No mooring connections will be allowed to be attached to the upper or lower float covers. Only tension type connections perpendicular to the outer sidewall will be approved. All mooring connections shall be stainless steel.
- 7.6 Floats shall be constructed of polyester fiberglass resins and shall have a resin/glass content of 70% resin and 30% glass. A minimum 0.014" thick gel coat shall cover the entire outer float shell.
- 7.7 A moisture inhibitor, such a N.P.G. (neopenthal glycol) or equal, and an ultraviolet inhibitor, such a UV9 or equal, shall be used to protect the float from moisture and sunlight damage.
- 7.8 The construction of the float shall be such that no under-water joints shall be used. Joints used to connect the top coverlid shall be overlapped a minimum of 1-1/2", both parts of all joints shall be ground to glass fiber and a resin/glass adhesive shall be applied to complete a 100% monolithic glass-to-glass bond.
- 7.9 The float construction shall be such that the volute will distribute the load of the entire motor, drive, diffusion head and volute static load plus, the entire dynamic load from the propeller thrust and radial forces by spreading these forces uniformly around the full 360° circumference of the float's central core. Point connected joints or point stressed connections will not be accepted.

7.10 The minimum flexural strength of the fiberglass construction materials shall be 26,000 psi and the minimum tensile strength shall be 10,000 psi.

8. PROPELLER

8.1 The propeller shall be a two-blade, left-handed, marine type precision casting of stainless steel, and shall be specifically designed for the application intended. It shall be a self-cleaning type that will not accumulate fibers, rags, stringy materials, etc. The propeller will have a diameter not allowing a greater clearance with the volute of 1/4".

8.2 Each propeller blade shall be pitched so that the pitch angle and rake angle are within ± 2 percent of the other blade(s).

8.3 The propeller shall be pitched so that the drive motor is loaded between 88% and 94% of full load nameplate horsepower.

8.4 Units using inclined screw impellers will not be acceptable.

8.5 The propeller must be attached to the motor shaft with a hardened stainless steel pin and set screw. No tapered, threaded shafts with nut fasteners will be acceptable.

9. VOLUTE

9.1 The propeller shall operate in a volute made of 304 stainless steel and shall be a minimum of 6-13/32" in diameter. It shall be round and true so that propeller blade tip clearance is uniform within the volute as it rotates. The volute shall have a minimum of 3/16" wall thickness, and a minimum of four full-length stainless steel gussets shall be welded on a 90° spacing around the circumference of the volute between the top and bottom flanges.

9.2 The volute shall have a large machined flange at its top extremity that completely encircles the volute, and this flange shall match a similar flange on the bottom of the diffusion head to provide for a bolted, machined flange-to-flange fit to provide uniform distribution of the dynamic loads generated by the propeller and the static weight of the motor and drive. A 360° machined index in the upper flange shall provide concentric alignment of the propeller in the volute by engaging the inside diameter of the mating flange on the diffusion head. Bolt holes alone will not be acceptable to locate the important alignment of the propeller.

9.3 Fiberglass volutes, or carbon steel volutes that are fiberglass, steel or stainless steel lined are not acceptable.

10. INTAKE CONE

- 10.1 The intake cone shall be fabricated from 0.135 " 304 stainless steel having a gradually expanding opening outward to the intake end. The length and inlet diameter shall be sufficient to provide uniform inlet hydraulics so that no increase in vibration is caused due to its shape or size. The minimum acceptable length is 12 " and minimum inlet diameter is 12-1/4 ".
- 10.2 The material used to fabricate the intake cone shall be structurally sufficient to support the weight of the entire aerator assembly when the aerator is freestanding on dry ground.
- 10.3 For maximum in-depth mixing efficiency, the intake cone shall be designed so that the suction lift from the aerator propeller is vertical from the liquid depth below the aerator. Unless specifically required for anti-erosion requirements, side or angle entry suction inlets will not be approved. Fiberglass intake cones are not allowed.

11. BALANCING

- 11.1 The entire rotating assembly including the motor rotor, shaft, shaft accessories, and impeller shall be dynamically balanced to within 2.0 mils peak-to-peak horizontal displacement measured at the upper and lower motor bearing. Measurements shall be taken at a frequency equivalent to the motor RPM.
- 11.2 Measurements shall be taken with the motor in a vertical, shaft down position and with the entire power section mounted on resilient pads.

12. DRAFT TUBE

Each unit shall be supplied with a draft tube that will provide an extension of the intake and will increase the effective mixing depth of the unit.

In deep lagoons or tanks, the draft tube shall permit deeper intake, promoting complete oxygen dispersion in activated sludge. The draft tube shall also promote complete solids suspension.

An anti-vortex cross is welded to the cone.
The draft tube shall be constructed of stainless steel.

13. MOORING

- 13.1 The anchor cable shall be installed as recommended by the manufacturer so the aerator shall be permitted to rise and fall with some water level variations but will have a minimum lateral movement.

- 13.2 The maximum amount of anticipated water level variation is 1/2 feet.
- 13.3 Anchor cable shall be 7 x 19 construction, 304 stainless steel and 1/4" diameter.
- 13.4 Mooring hardware (thimbles and clips) shall be of 316 stainless steel. Galvanized hardware is not acceptable.

14. ELECTRICAL SERVICE CABLE

- 14.1 Electrical service cable shall be provided and shall be a continuous length (non-spliced). The cable shall have three power conductors and a ground conductor.
- 14.2 Conductors shall be flexible type annealed copper stranded. Each conductor, including the ground conductor, shall be insulated. Cables containing an uninsulated ground conductor will not be acceptable.
- 14.3 The insulated conductors shall be assembled together with a non-hygroscopic filler material.
- 14.4 Outer jacket shall be high quality CPE, PVC, TPE or equal, and shall be rated at a conductor operating temperature of not less than 90°C.
- 14.5 The cable shall be rated for hard usage outdoor service and shall be resistant to oil, sunlight, ozone, grease, acids, water, abrasion and impact.

15. INSTALLATION, OPERATING, AND MAINTENANCE MANUALS

- 15.1 The aerator manufacturer shall provide 6 copies of a detailed manual that shall include specific instructions for receiving and handling, assembly, mooring, wiring, installation, repair and service, storage, troubleshooting, detailed exploded drawings of the unit, and a full parts list.
- 15.2 In addition, the manual shall contain complete detailed instructions on the balancing procedure to be used for rebalancing the propeller after it has been in service for an extended period of time. These instructions shall include a general procedural description, a detailed explanation of preparing the unit for balancing and the balancing procedure for propellers.
- 15.3 These manuals shall be submitted for review, along with other general submittal information, including detailed drawings, brochures, cut-sheets, motor data sheets, etc., as a part of the approval process.

16. MANUFACTURER

The aerator specified herein shall be the Aqua-Jet Endura series as manufactured by Aqua-Aerobic Systems or approved equal.

17. WARRANTY

The Aerator shall be warranted for three years for defects in materials and workmanship.

END OF SECTION

SECTION 467321

AEROBIC DIGESTER

1. SYSTEM SOURCE & QUALITY ASSURANCE

The Aerobic Digester System shall be supplied by a company of good reputation that is regularly engaged in the manufacture and fabrication of Aerobic Digester wastewater treatment systems. The manufacturer's experience shall include a minimum of ten (10) installations where equipment of similar size and design has been in operation successfully in a similar process for a minimum of ten (10) years. As a minimum, the supplier shall be the manufacturer of the following components: Floating weir and controls.

The Contractor shall assign full responsibility for the functional operation of all Aerobic Digester System components to a Single Source Supplier. This Supplier shall be responsible for all engineering necessary in order to select, furnish, inspect the installing contractor's equipment installation and connections, calibrate, and place into operation the Aerobic Digester System along with all other equipment and accessories as specified herein.

2. SYSTEM OPERATION AND MAINTENANCE MANUALS

Complete system Operation and Maintenance manuals shall be available in hardcopy and electronic form. The electronic form shall be provided in .pdf format and be fully bookmarked. Manuals shall address:

- General project information
- Installation and start-up
- Process design and operational control description
- Mechanical, electrical and field instrumentation component descriptions
- Maintenance and troubleshooting
- Mechanical and electrical drawings

3. MOTOR COMPLIANCE

Motors shall be in compliance with the Energy Independence and Security Act of 2007 (EISA 2007).

All three phase motors and components shall be 460 volt, 60 hertz.
All single phase components shall be 115 volt, 60 hertz.

4. INSTALLATION

The installation of the equipment furnished by the manufacturer shall be the responsibility of the installing contractor in accordance with all requirements of the contract documents.

5. SPECIFICATION PRECEDENCE

The specifications for equipment and controls under this section supersede specifications for equipment and controls specified elsewhere in the contract documents and drawings. Purchased components such as gear reducers, pumps, motors, valves, and actuators shall be provided with standard recommended manufacturers paint, unless otherwise specified within this section.

6. ELECTRICAL CLASSIFICATION

The Aerobic Digester area electrical classification shall be Nonclassified. Motors within the basin shall be rated for a temperature code T2A (280 Deg.C).

7. ACCEPTABLE MANUFACTURERS

These specifications and accompanying drawings are based upon the use of the Aerobic Digester System manufactured by Aqua-Aerobic Systems, Inc or approved equal.

8. SERVICE

The equipment manufacturer shall furnish the services of a factory trained representative for a maximum of 1 trip(s) and 4 eight-hour days at the jobsite to inspect the installing contractor's equipment installation, supervise the initial operation of the equipment, instruct the plant operating personnel in proper operation and maintenance, and provide process assistance.

If additional service is required due to the mechanisms not being fully operational, at the time of service requested by the contractor, the additional service days will be at the contractor's expense.

The selected Aerobic Digester manufacturer shall have a free troubleshooting help line available 24 hours a day, 365 days per year for the life of the plant. The line shall connect to a live service technician who shall have the capability of connecting to the control panel via internet, with the operator's permission.

9. WARRANTY

The Manufacturer shall provide a written warranty against defects in materials and workmanship. Manufacturer shall warrant the goods provided by the Manufacturer to be free from defects in materials and workmanship under normal conditions and use for a period of one (1) year from the date the goods are put into service, or eighteen (18) months from shipment of equipment, whichever first shall occur. This warranty shall not apply to any goods or part which

has been altered, applied, operated or installed contrary to the Manufacturer's instructions or subject to misuse, chemical attack/degradation, negligence or accident.

10. AEROBIC DIGESTER FUNCTIONAL REQUIREMENT

The manufacturer of the AEROBIC DIGESTER system shall be completely responsible for the proper design of their system, including but not limited to; floating weir, diffused aeration, submersible WAS pump, and controls. All equipment shall perform as specified and the completed installation shall operate in accordance with the requirements of the plans and specifications.

Any supplier wishing to bid other than the specified supplier shall provide the following:

A letter signed by an officer of the company certifying compliance with the specifications without exception. In addition, the supplier must certify the proposed motors will be Warranted by the motor supplier as outlined in the specified Warranty.

A field test report documenting the proposed or similar units have been field tested.

Proof of manufacturing and testing facilities.

Installation list with contacts and phone numbers for a minimum of ten installations of similar size in operation for ten years.

FAILURE FOR THE CONTRACTOR TO SUPPLY THIS INFORMATION WITH THE BID MAY BE CAUSE FOR DISQUALIFICATION OF THE CONTRACTORS BID.

11. AEROBIC DIGESTER STRUCTURE

The Aerobic Digester system shall be field erected as shown on the contract drawings and summarized below:

Basin Quantity	1
Inside Dimensions:	
Basin Diameter	35 feet
Side Water Depth:	
Minimum Operating Level (LWL)	5.5 feet SWD
Maximum Operating Level	7.8 feet SWD
Top Of Wall	10 feet

No hydraulic profile modifications shall be permitted.

12. FIXED COARSE BUBBLE DIFFUSER SYSTEM

Design aeration system to transfer the following minimum amount of oxygen per day at standard conditions in clean water at the specified submergence, air rate and pressure.

Airflow per basin: 577 SCFM
Pressure at Top of Drop Pipe: 2.95 PSIG
Diffuser Submergence: 4.5 feet
Diffuser Quantity: 20 Duplex Tubes per basin

Diameters
Riser Pipe: 4 inch

Materials of Construction
Manifold/Headers: 304 stainless steel
Supports: 304 stainless steel
Riser Pipe: 304 stainless steel

Basin Connection: Anchors by System Manufacturer

13. MATERIALS AND FABRICATION

Fabricate all welded parts and assemblies from sheets and plates of stainless steel with a 2D finish conforming to ASTM A240, 554, 774, 778. Fabricate non-welded parts and flanges from sheets, plates or bars of 304 stainless steel conforming to ASTM A240 or ASTM A276. Weld in the factory with ER 316L filler wire using MIG, TIG or plasma-arc inert gas welding processes. Provide a cross section equal to or greater than the parent metal. Clean all welded stainless steel surfaces and welds after fabrication to remove weld splatter and finish clean all interior and exterior welds by full immersion pickling and rinse with water to remove all carbon deposits and contaminants to regenerate a uniform corrosion resistant chromium oxide film per ASTM A380 Section 6.2.11, Table A2.1 Annex A2 and Section 8.3.

14. DROP PIPES

Provide a minimum 12 ga. stainless steel drop pipe from the air main connection to a point 3 feet above the air distribution header. Provide a stainless steel flange with a 150-pound drilling at the

top connection. Provide a stainless steel gasketed coupling for connection to the air distribution header.

15. AIR DISTRIBUTION HEADERS

Provide minimum 12 ga. stainless steel air distribution headers for connection to the drop pipe. Fabricate air distribution headers with flanged joints or expansion joints. Design piping with eccentric reducers for changes in diameter to maintain constant invert elevation. Provide piping with removable or welded end caps. Design piping, pipe joints and supports to resist expansion/contraction thrust forces of the air distribution headers over a temperature range of 125° F.

16. PIPE SUPPORTS

Provide each section of air distribution header with a minimum of two supports. Support spacing to be limited to a maximum of 18 feet. Design all supports to allow for thermal expansion and contraction forces over a temperature range of 125° F and to minimize stress build up in the piping system. Design supports to be adjustable without removing the air distribution header from the support. Design supports to include hold down guide straps, support structure and two anchor bolts. Design guide straps with a 2 inch minimum width to eliminate point load on piping and minimize binding. Design support for a total of 1 inch lateral adjustment and 4 inch vertical adjustment for leveling within 3/8 inch of a common plane. Attach supports to tank floor with stainless steel anchor bolts.

17. DIFFUSER ASSEMBLIES

Furnish diffuser assemblies including diffuser, diffuser connector and air flow control orifice.

18. AIR DIFFUSER

Design diffuser with cast stainless steel alloy equivalent to 316L stainless steel schedule 80 – 3/4 inch NPT threaded nozzle, air reservoir, air exit ports and bottom deflector. Design diffuser with a minimum air release perimeter of 48 inches. Locate exit ports discharging air into liquid on horizontal planes at two levels. Provide deflector below each diffuser for its full length and width. Design deflector to direct the liquid being aerated along the diffuser reservoir walls so that the air exits through the ports and is sheared into small bubbles and distributed into the liquid.

19. DIFFUSER CONNECTORS

Design diffuser connector for two diffusers. Furnish PVC plugs for all unused diffuser connectors. Design diffuser connector with cast stainless steel alloy equivalent to 316L stainless steel. Provide connector so that air exiting the diffusers does not interfere with the air

distribution header. Factory weld connector to the invert centerline of the air distribution header with a full penetration butt weld. Reinforce the connector header weld joint by providing and continuously welding gussets between the vertical side wall of the header and the connector ends to limit long term flexure failure. Minimum gusset thickness to be 1/8 inch. Design connector to resist a vertical dead load applied to the threaded end of the connector that results in a bending moment of 1000 inch-lbs without exceeding 24,000 psi design stress in any part of the air distribution header wall or connector.

20. ANCHOR BOLTS

Design a mechanical or adhesive anchor bolt system for embedment in 4000 psi concrete with a pullout safety factor of 4.

21. BLOWERS

Furnish three phase rotary lobe type, positive displacement blowers as described below with premium efficient, T.E.F.C., Class F insulation, Teco, Siemens, or equal motor. The blowers shall be manifolded for individual and/or combined operation.

Quantity:	2 per basin (1 Duty, 1 Standby)
Motor Size:	20 HP
Manufacturer:	Aerzen
Model Number:	GM 25S
Airflow Rate:	557 SCFM per blower
Discharge Pressure:	3.95 PSIG
Enclosure:	Powder Coated Galvanized Steel Acoustic Hood with oil drip pan

Discharge Isolation Valve

Size:	6 inches
Seat material:	EPDM

Each blower assembly shall be complete and mounted on a base weldment with four-corner anti-vibration mountings, designed for direct application on a concrete slab or other solid foundation. Each assembly shall be suitable for shipment as a complete unit, factory assembled (less discharge pipe fittings) as much as possible to facilitate shipping and handling.

Equipment shall include a blower, electric motor, belts and sheaves, inlet package, discharge silencer, discharge check valve, rubber inlet sleeve and discharge connection, pressure relief valve, butterfly discharge isolation valve, and rubber expansion joint. A personnel protection guard shall be included over the belts and sheaves.

22. Discharge Pressure Gauge

Provide a discharge liquid filled pressure gauge to be equivalent to U.S. Gauge, Ashcroft, or approved equal.

Range: 0-15 psig.

Dial: 2 ½", 270 degree scale.

Case: 300 Series stainless steel.

Accuracy: ±3-2-3% of span (Grade B)

23. BLOWER ENCLOSURE

A sound enclosure shall be provided for each blower package to help reduce the resultant noise level. The sound enclosure shall encompass the entire blower package for maximum noise attenuation. The enclosure shall be constructed of durable powder coated carbon steel with a sound absorbing internal surface. The walls and ceilings shall be shop assembled with all corners and joints properly insulated to prevent noise leakage and maintain the attenuation levels of the room. The blower package and sound enclosure shall ship as a unitized one piece assembly. Maintenance access doors shall be provided to facilitate servicing of the blower package. A baffled inlet shall be provided to allow supply and cooling air to enter the enclosure during the operation of the blower. An exhaust fan sized for proper enclosure ventilation will be supplied.

24. PRESSURE TRANSDUCER

Furnish submersible pressure transducer unit(s) constructed of stainless steel as specified herein. Transducer output shall be a 4-20 mA signal.

Quantity: 1 per basin

Model: Keller Levelrat

Mounting Materials of Construction

Support Pipe: PVC

Supports: 304 stainless steel

Anchors: 304 stainless steel

Basin Connection: Adhesive anchors by System Manufacturer

Transducers shall be suspended on a removable assembly consisting of support pipe and hose. Removable assembly shall be supported by steel supports and guide rail, and anchors. Field attachment of the guide rail and supports to the basin shall be the responsibility of the installing contractor. A moisture excluding aneroid bellows shall be supplied loose for installation in the

junction box/ disconnect. Attachment and supply of the junction box/disconnect at the basin wall shall be the responsibility of the installing contractor.

Field attachment of the pressure transducer mounting brackets to the tank shall be the responsibility of the installing contractor.

25. LEVEL SENSORS

Furnish one (1) level sensor assembly consisting of an Anchor Scientific model GSI 40NONC float switch with a smooth, chemical resistant polypropylene casing, and 316 stainless steel mounting bracket for each basin. Each float switch shall be provided with a three conductor electrical cable. Electrical cable shall terminate at a junction box/disconnect located at the basin wall. Field wiring and junction box/disconnect shall be provided by the installing contractor.

Field attachment of the level sensor assembly to the tank shall be the responsibility of the installing contractor.

26. CONTROL PANEL WITHOUT MOTOR STARTERS

The control system shall be designed to optimize the digester process while minimizing operator attention and to accommodate the continuous maximum daily flow without adjusting cycle structures. The control software program shall be factory tested prior to installation at the jobsite.

The control system shall be a timer based system with level overrides and shall provide control, sequence, monitoring, and alarm annunciation capabilities. The operator shall be able to access the timer values and set points through the operator interface panel to allow for adjustment of cycle times and system flexibility. The control system shall be designed to automatically accommodate the plant's full range of loads and flows.

A complete control system shall be provided as described in the following and as shown on the contract drawings. The control system shall include 115 volt control circuit breaker, microprocessor control, operator interface display, indicator lights, and HAND-OFF-AUTOMATIC selector switches.

The incoming service of the control system shall be 115 volt, 60 hertz, single-phase. Controls for the equipment listed below shall be provided within the digester control panel. Elapsed time indication shall be provided through (the operator interface of) (hard-wired elapsed time meters located within) the SBR (MixAir) control panel for equipment indicated by an asterisk(*).

27. DIGESTER EQUIPMENT DESCRIPTION

3 HP Sludge Pump(s)* (qty. = 1)

- 20 HP Blower(s)* (qty. = 2)
- 4-20 mA Pressure Transducer(s) (qty. = 1)
- Level Sensors (qty. = 1)

28. CONTROL PANEL WIRING AND ASSEMBLY

All control enclosures shall be custom assembled and wired in an Underwriters Laboratories (UL) certified cabinet shop using quality materials and labor. Short circuit rating of control enclosure shall be 5 kA RMS symmetrical @ 115VAC maximum.

All control panel single conductor wire shall be 16 AWG multi-strand machine tool wire (MTW) minimum, with PVC insulation.

Wire colors are as follows:

208 VAC or higher	-	Black
120 VAC control power	-	Red
Neutral	-	White
Ground	-	Green with Yellow Stripe
Power from remote source	-	Orange
Neutral from remote source	-	White with Orange Stripe
24 VDC (+)	-	Blue
24 VDC (-)	-	White with Blue Stripe
Intrinsically Safe	-	Light Blue

All wires shall be clearly marked with an identification number consistent with the wiring schematic drawing. Wire markers shall be a thermal transfer printable type. The material shall be a self-laminating vinyl. Labels shall be Brady THT-9-427-10 or approved equal.

Wiring inside the control panel shall be run in PVC wiring duct rated for continuous temperatures up to 122° F (50°C). Devices mounted in the enclosure door shall have wires run in spiral wrap to avoid pinch points when opening and closing the door.

Control components mounted internal and external to the enclosure shall be mounted with stainless steel hardware and clearly labeled with a plastic identification nametag. The tag shall be white with black lettering.

29. CONTROL PANEL QUALITY ASSURANCE

All Control panels shall be UL certified. Testing by manufacturer's electrical engineering prior to releasing for shipment shall be completed. Testing shall consist of the following:

Point to point testing of all wiring prior to application of power

Intended supply voltage shall be applied to the enclosure
All components shall be tested for proper operation and calibration
The PLC and operator interface program shall be loaded and functionally checked
All components shall be checked to confirm proper mounting specifications have been followed
Enclosure shall be inspected for defects and repaired if necessary
All labeling of wires and devices are correct, properly installed and clean

The manufacturer shall finalize the factory checkout by completing a control panel checklist to document all testing completed above.

Upon the successful completion of the control testing of the enclosure assembly, all applicable documentation (i.e. finalized drawing set, signed control checklist cover page, device data sheets, etc.) shall be placed in the drawing pocket of the enclosure.

30. CONTROL ENCLOSURE

The automatic controls shall be provided in a UL listed, NEMA Type 12 mild steel (12 gauge) floor mount enclosure that provides a degree of protection for electrical controls and components from dust, dripping water and external condensation of non-corrosive liquids. The enclosure is intended for indoor installation. Enclosure shall include gasketed overlapping doors with a 3-point latch mechanism operated by an oil tight key-lock handle. The enclosure shall have white polyester powder paint inside with ANSI 61 gray polyester powder paint outside over phosphatized surfaces. The enclosure shall include a painted white mild steel (10 gauge) sub-panel mounted with collar studs. Enclosure shall be manufactured by Hoffman or approved equal.

The control enclosure shall be mounted remotely.

31. CORROSION INHIBITOR

Each control enclosure assembly shall be provided with corrosion inhibitors to protect interior electrical components from damage caused by high humidity. The corrosion inhibitors shall be installed prior to shipment to provide protection during shipment and storage of the enclosure. The corrosion inhibitor shall be Hoffman AHCI5E or approved equal.

32. CIRCUIT BREAKER

All single phase branch or supplementary circuits shall be protected with a single-pole, C-Curve rated circuit breaker. Circuit breakers shall be rated for 240 VAC maximum, 50/60 Hz and UL 489 listed. Supplementary and branch protection circuit breakers shall be Merlin Gerin Multi 9 or approved equal.

33. FUSE

Properly rated fuses and fuse holders shall be provided for protection of individual control devices (discrete and analog signals) mounted outside of the enclosure. Each fuse shall be housed in a hinged type fuse block to protect against contact with the fuse. Fuses shall be rated up to 250 VAC and be Littelfuse or approved equal. Fuse holders for discrete devices shall be rated to 600 VAC and 30 Amps. Fuse holders for analog devices shall be rated to 300 VAC and 15 Amps. Fuse holders shall be Allen Bradley 1492 or approved equal.

34. OPERATOR DEVICE

Operator devices (pushbuttons and selector switches) shall be mounted through the control enclosure door for all automatic controlled equipment. Transformer type pilot lights and illuminated pushbuttons shall be provided for indication of an operation status. Lights shall be a 6 VAC incandescent type lamp. Color coding shall be applied as required and is as follows:

Amber – Alarm active, caution

Green – Valve open, motor running

Red – Valve closed

White - Information

All operator devices shall be UL Listed, 30.5mm style, NEMA Type 4X rated, oil and water tight with finger safe guards located on the contact blocks to prevent accidental contact with wire connections. Operator device function shall be identified with an engraved white Gravoply nameplate with black letters. Operator devices shall be Square D 9001 or approved equal.

35. HIGH FREQUENCY NOISE FILTER

A UL listed active tracking filter shall be provided to protect the PLC and HMI power feeds from high-frequency noise and low-energy transients. It shall be designed for a single phase input voltage of 120VAC operating at 50/60 Hz. The unit shall provide surge capacity of 25,000 amps and provide transient protection in all modes (Line to neutral, line to ground and neutral to ground). The noise filter shall be a SolaHD STFV or approved equal.

36. GROUND FAULT DUPLEX RECEPTACLE

A UL listed ground fault circuit interrupter (GFCI) duplex receptacle shall be provided within the panel for instrument (e.g. programming terminal, modem, etc.) use only. The receptacle shall be protected with a 5 Amp circuit breaker. The receptacle shall carry a 20A / 120VAC rating. The electro-mechanical circuit interrupter shall be double-pole and trip free (GFCI protection and shall not be overridden by holding reset button). Built-in transient suppression shall protect GFCI's internal circuitry from voltage transients. Receptacle shall be Hubbell DRUBGFI20 or approved equal.

37. 24 VOLT DC POWER SUPPLY

A UL listed, industrial grade, compact power supply shall be supplied to provide 24 VDC power to such rated components. The power supply shall be DIN rail mounted and functional with input voltage of 100 to 240 VAC (single-phase) incoming control power. The power supply shall have a green LED which shall be illuminated when output voltage is “OK”. The power supply shall be an Allen Bradley 1606 or approved equal.

38. CONTROL RELAY

UL listed control relays for general control purposes shall be supplied with a pilot light to indicate when the coil is in an energized state. The relay socket shall be panel or DIN rail mounted inside the enclosure. The relays shall provide the following ratings: 120VAC coil, 10A contact rating (thermal), 250 VAC insulation rating and 5 million mechanical life cycles. Relays shall be Allen Bradley 700-HK, Square D, or approved equal.

39. TERMINAL BLOCK

Standard feed-through screw terminal blocks, DIN rail mounted, shall be supplied for all point to point wiring connections. All terminals shall be numbered per the wiring schematic with printed markers. Terminals shall carry a 600V AC/DC voltage rating. Terminal blocks shall be Allen-Bradley 1492-J4 (35A max) and 1492-J16 (85A max) or approved equal.

40. PROGRAMMABLE LOGIC CONTROLLER

Automatic operation of the Aerobic Digester shall be controlled through a programmable logic controller (PLC) mounted inside the main control panel. The PLC components shall consist of a power supply, CPU, discrete input and output modules and analog input and output modules. The processor unit shall include built-in USB and two (2) Ethernet IP communication ports. All input and output points supplied (including unused) shall be wired to terminal blocks. Processor design characteristics shall include: 1.0MB user memory size, real-time clock and calendar, battery backed RAM and an operating temperature range between 32 °F and 140°F. The PLC processor shall be an Allen-Bradley CompactLogix 1769-L30ER or approved equal.

Modular equipment shall be provided to complete the PLC system. These Allen-Bradley components include: 1769-PA4 – Power Supply, 1769-IA16 – Discrete input (16 point) modules, 1769-OW16 – Discrete output (16 point) modules and 1769-IF8 – Analog input (8 point) modules, 1769-OF8CI – Analog output (4 point) modules.

41. PLC POWER SUPPLY

Input voltage range of 85-265 / 170-265 VAC, 47-63 Hz, maximum inrush current of 30 amps, backplane output current of 4 amps @ 5V or 2 amps @ 24V, internal fuse protection, ambient operating temperature of 32°F to 140°F, Class I, Division 2 hazardous location certified, UL Listed.

42. DISCRETE INPUT MODULE

Operating voltage of 79 to 132 VAC at 47 to 63 Hz, backplane current draw at 5VDC = 115mA , off-state current 2.5mA maximum, maximum inrush current 250mA, LED status indication of each point, ambient operating temperature of 32°F to 140°F, UL Listed.

43. DISCRETE OUTPUT MODULE

Operating voltage of 5 to 265 VAC at 47 to 63 Hz / 5 to 125 VDC, backplane current draw at 5 VDC = 205mA , at 24VDC = 180mA, off-state current leakage is 1.0mA, LED status indication of each point, ambient operating temperature of 32°F to 140°F, UL Listed.

44. ANALOG INPUT MODULE

Backplane current draw at 5 VDC = 120mA, at 24VDC = 70mA, LED status indication of each point, ambient operating temperature of 32°F to 140°F, UL Listed.

45. ANALOG OUTPUT MODULE

Backplane current draw at 5 VDC = 120mA, at 24VDC = 170mA, LED status indication of each point, ambient operating temperature of 32°F to 140°F, UL Listed.

46. ETHERNET SWITCH

An unmanaged Ethernet switch shall be provided inside the control enclosure to provide connectivity between the PLC, operator interface and plant networking. The switch shall support both 10 and 100 Mbit/s operation. The switch shall have five (5) 10/100Base-T ports with RJ-45 sockets and shall support auto-crossing, auto-negotiation and auto-polarity. Maximum distance between devices shall be 100m.

The unit shall be DIN rail mounted and require 24VDC power. Diagnostic LEDs for power and connection status shall be included. The Ethernet switch shall be UL listed and manufactured by Allen-Bradley Stratix 2000 1783-US5T, or approved equal.

47. REMOTE ETHERNET ACCESS GATEWAY

A cULus marked, remote access VPN gateway shall be supplied to securely connect to a PLC via the Internet using an Ethernet port and a secure VPN tunnel. The gateway can be DIN rail or

wall screw mounting and shall provide WAN/LAN 10/100 Mb Ethernet ports. The gateway shall be a Ewon Cosy + ETH.

48. HUMAN MACHINE INTERFACE

The operator interface shall be a NEMA Type 12, 13, 4X rated, 6.5" diagonal, color touchscreen display with Ethernet and serial communications. The interface shall be a liquid crystal display (LCD). The display type shall be color active matrix thin-film transistor (TFT) with 640 x 480 pixel resolution. The rated operating temperature shall be 32° to 131° F (0° to 55° C). The operator interface shall be an Allen Bradley PanelView Plus 7 Performance 7".

49. MANUFACTURER

The aerator specified herein shall be the Aqua-Jet Endura series as manufactured by Aqua-Aerobic Systems or approved equal.

50. WARRANTY

All equipment shall be warranted for three years for defects in materials and workmanship.

END OF SECTION

SECTION 467621

BELT FILTER PRESS

PART 1 - GENERAL REQUIREMENTS

1.01 Scope of Work

- A. This section shall include furnishing One (1) belt filter press specified and indicated on the drawings and as required to meet the specified performance requirements.

1.02 Workmanship and Design

- A. All components of the sludge dewatering equipment shall be engineered for long, continuous, and uninterrupted service. Provisions shall be made for easy lubrication, adjustment, and replacement of all parts.

1.03 System Description

- A. The sludge dewatering system shall consist of One (1) belt filter press and all appurtenances. The belt filter press shall be a complete prefabricated unit consisting of at least a sludge conditioning system, a magnetic flow meter, a gravity drainage section, a pressure section, a belt alignment and tensioning system and a belt washing system. Only units having a measured belt width of 1.5 meters shall be considered acceptable under this specification. The width of the belt area in actual contact with the sludge, known as the effective belt width, shall be a minimum of 67".

The overall dimensions of the belt filter press room shall be such that the installation of the press allows adequate room on one side for the removal of rollers, as well as a minimum clearance of 3'-0" on all other sides of the press. The overall height, width, and length of each belt filter press shall not exceed 8.30 ft. height, 10.00 ft. width and 20.84 ft. length respectively.

1.04 Patents

- A. The manufacturer warrants that the use of this system and its equipment, in the process for which the system has been expressly designed, will not infringe on any U.S. or foreign patents or patents pending. In the event of any claim of infringement the manufacturer shall defend and indemnify the owner free from any liabilities associated with the use of the patented equipment or process.

The contractor hereby grants to the owner, in perpetuity, a paid-up license to use any inventions covered by patent or patents pending, owned, or controlled by the supplier in the operation of the facility being constructed in conjunction with the

equipment supplied under this contract, but without the right to grant sublicenses.

1.05 Warranty

- A. The manufacturer shall warrant, in writing, that all equipment supplied by them shall be free from defects in material and workmanship, for a period of twelve (12) months from the date of start up, not to exceed eighteen (18) months from the date of delivery, unless noted otherwise within the specifications.

1.06 Conditions of Service

- A. The sludge dewatering equipment shall be designed to adequately condition and dewater the sludge such that a dewatered sludge cake is produced that easily discharges from the dewatering unit, without blinding, and that may be handled by the conveying equipment.

Each unit shall be designed to operate in the environment for which it is intended, continuously or intermittently on demand, and shall perform the required dewatering operations without spillage of water or sludge beyond the nominal machine envelope.

The description of the sludge to be fed to the belt filter press is as follows:

Type of sludge: digested waste activated

Feed Solids, percent d.w.s.: 2%

1.07 Quality Assurance

- A. System Responsibility: Vested responsibility for operation and control of the BFP system, which is comprised of all equipment controlled by the BFP control panel, is the BFP manufacturers.
- B. Experience Qualification: A qualified manufacturer is one having a minimum of ten (10) units of the proposed model, each having been in operation for a period of not less than five (5) years.
- C. The belt filter press manufacturer is to have a minimum 20 years of development, assembly and manufacturing experience. No exceptions to this requirement shall be accepted.
- D. Source Quality Control: The belt filter press shall be designed, fabricated, assembled, and tested by the belt filter press manufacturer in their own facility. In order to provide maximum quality assurance, all aspects of the design, fabrication, and assembly, shall be performed by personnel employed by the manufacturer. The belt filter press manufacturer shall at the same facility

maintain a suitable spare parts inventory.

- E. Factory Quality Control Test: Prior to shipment, the belt filter press and control panel shall be factory tested at the place of assembly. Factory test each pre-assembled, pre-wired, lubricated, and aligned BFP and its associated control panel to be supplied to the job site. Prior to shipment, verify through a one-hour continuous operating test that the BFP and associated equipment operate smoothly, noiselessly, vibration free, and without overheating of any bearing or motor. Particular attention must be given to assure that the BFP is properly aligned for maintaining the centerline-to-centerline tracking of the belts relative to the machine. Submit a certified test report to the Engineer for approval, prior to shipping that demonstrates compliance with all applicable industry standards, manufacturing quality control, and the functional intent of these Specifications.
- F. The owner/engineer shall, at their option, be permitted to witness the factory quality control test at the manufacturer's facility. The manufacturer shall give the owner/engineer a minimum of two- (2) weeks notice prior to testing.
- G. Belt Filter Press shall be manufactured by:
1. Alfa Laval
 2. Charter Machine Company
 3. Engineer Approved Equal

PART II - MECHANICAL REQUIREMENTS

2.01 Materials and Coatings

- A. All materials used in the construction of the sludge dewatering equipment shall be of the best quality and entirely suitable in every respect for the service required. All structural steel shall conform to the latest ASTM Standard Specification for Structural Steel, Designation A36/A36M-93b. All iron castings shall conform to the latest Standard Specifications for Gray Iron Castings, and shall be of a class suitable for the purpose intended. Other materials shall conform to the ASTM Specifications where such specifications exist; the use of such materials shall be based on continuous and successful use under similar conditions of service.

All electrical components shall be U.L. listed where such listing exists and all electrical control panels shall be assembled in U.L. approved facilities. All structural carbon steel plates and shapes shall have a minimum thickness of 1/4 inch and shall be hot dip galvanized in accordance with ASTM A-123.

All structural carbon steel plates and shapes shall have a minimum thickness of 1/4 inch and shall be hot dip galvanized in accordance with ASTM A-123.

Unless specified otherwise herein, all metals in contact with polyelectrolyte or sludge, and all other components specified to be stainless steel, shall be type 316L

stainless steel.

The following materials and coatings shall be provided for the belt filter press and related components unless specified otherwise herein:

Bearing housings	Nylon coated, cast iron
Belt support grids	Stainless steel, fitted with UHMW polyethylene wiper bars
Belt wash housing	Stainless steel, 14 gauge.
Belt wash spray tube and nozzles	Stainless steel.
Belt wash piping	Schedule 80 PVC, 1 1/2 inch.
Chicanes	Galvanized steel support rods, galvanized cast iron holders and U.H.M.W. polyethylene blades.
Chutes (feed and discharge) (if required)	Stainless steel, 10 gauge.
Doctor blades	U.H.M.W. polyethylene.
Drain trays	Stainless steel, 14 gauge.
Drain tray piping	Schedule 40 PVC.
Electrical junction box	Stainless steel or FRP
Electrical conduit	SO Cord
Electrical switch enclosures	NEMA 4, press mounted
Frame	A36 steel, hot dip galvanized, ASTM A123, minimum 3.9 mils.
Hardware, fasteners, springs, clips, etc.	316 stainless steel.
Hydraulic cylinders: body:	FRP tube with high strength glass
filled nylon head rod:	Solid 316 stainless steel with hard surface
treatment	

Miscellaneous	Carbon steel surfaces to be hot dipped galvanized per ASTM A123
Polymer mixer housing	Cast 316ss Counterweight Cast iron, galvanized Injection ring UHMW polyethylene Splitter Manifold UHMW polyethylene
Rollers (solid)	Carbon steel, 1/2 -inch wall,. Drive rollers coated with Buna N rubber, 1/4 inch, other solid rollers coated with thermoplastic nylon, 25 mils.
Rollers (perforated)	1/4 -inch wall carbon steel hot dip galvanized, or nylon coated
Roller shafts	Forged steel ASTM 572 Grade 50, perforated roller shall have 8620
Sludge containment barriers	Stainless steel, 14 gauge.

- B. All hot dip galvanizing shall be applied in accordance with ASTM-A123 minimum 5-7 mil. Zinc flame spray shall not be considered an acceptable substitute to this specification.

Coating Properties	Test Method	Value
Hardness, Shore D	ASTM D-2240	77
Specific Gravity	ASTM D-792	1.06-1.20
Impact, RT & 45 F Direct Pass	ASTM D-2794	160 in lbs
Tensile Strength	ASTM D-638	6000 PSI
Elongation	ASTM D-638	15%
Melting Point	ASTM D-789	370 ⁰ F
Abrasion Resistance (varies with color)	ASTM D-4060 CS17/1000/1000	8-18 mg. Wt. loss Taper Abrader)

Buna N rubber coating shall have the following properties:

Tensile strength, ASTM D-412	2500 psi
Tear strength, die C, ASTM D-624	250 psi
Elongation at break, ASTM D-412	160%
Hardness, Shore A, ASTM D -676	90

2.02 Sludge Conditioning System

- A. Each belt filter press shall be provided with a sludge conditioning system, designed to efficiently mix polymer with the sludge and to adequately flocculate the sludge,

for optimum dewatering.

The sludge conditioning system shall be mounted upstream of the press and shall consist of an inline adjustable orifice venturi type mixer complete with polymer injection device.

The belt filter press manufacturer shall be required to provide, to the engineer, a proper layout for the system.

The sludge conditioning system shall be capable of providing the following performance:

- 1) The polymer and sludge must be instantly mixed (less than 1.0 seconds at 60 GPM).
- 2) Mixing energy must be independently adjustable during operation.
- 3) Flocculation time must be independently adjustable, by the displacement of flanged pipe sections, with the mixer, at a minimum of two locations in the sludge feed piping.
- 4) Magnetic flow meter accurately installed on the discharge line to the gravity section of the Belt Filter Press.

The sludge conditioning system shall meet the following mechanical specifications:

- 1) The in-line mixer shall have a flanged housing, an adjustable orifice plate, with shaft and o-ring seal, connected to an externally mounted lever and counterweight and a removable side plate for inspection and cleaning.
- 2) The open throat area of the mixer shall be fully adjustable downward and shall open automatically to prevent clogging.
- 3) The position of the counterweight on the externally mounted orifice plate lever shall be fully adjustable, within a 360 degree circle, to allow for adjustment of the mixing energy, regardless of mounting angle, while the unit is in operation.

The polymer mixer shall be designed specifically for its intended use. The use of modified check valves, static mixers, or mixers requiring a tank and motor driven propeller shall not be acceptable to this specification.

2.03 Structural Main Frame

- A. The structural main frame shall be fabricated of steel members conforming to AISC Standard Specifications for Structural Steel, into a rigid structure, adequately braced to

withstand intended loads without excessive vibration or deflection.

The frame shall have a minimum safety factor of > 5 and maximum deflection of 0.011 inches under maximum loading. The moment of inertia of the structural members shall be adequately chosen to provide the safety factor and deflection rate specified herein.

Maximum load on the frame shall be based on the summation of forces applied to the frame from roller mass forces, weight of the rollers including the sludge and belts and belt tension forces. Belt tension forces shall include, but not be limited to, a belt tension of 50 pli per belt plus the tension produced by the driving torque of the motor at nameplate ph. Certified calculations, showing the frame to be in compliance with the specification, shall be submitted as set forth in the contract documents.

The framework shall be of welded and/or bolted construction. All welding shall conform to the American Welding Society Structural Welding Code.

The structure shall be designed for installation on a prepared concrete foundation and secured with anchor bolts. Permanent lifting lugs shall be provided as necessary to allow installation and removal of the belt filter press.

The construction shall allow easy access and visual inspection of all internal components.

The manufacturer shall warrant the frame and the coating for a period of three years from the date of start-up, not to exceed three and a half years from the date of delivery. The frame shall not require preventive maintenance during the warranty period. Any defects or corrosion occurring within the warranty period shall be repaired or replaced at no additional cost to the owner.

2.04 Gravity Drainage Section

A. Each belt filter press shall be furnished with an independent gravity drainage section to accept sludge from the sludge conditioning system. The gravity drainage section shall be furnished with a sludge feed chute and an inlet distributor to evenly distribute the conditioned sludge over the effective width of the moving filter belt. The independent gravity drainage section shall be designed so that it can be operated, on demand, as either just a thickening device only or as a pre-thickening device prior to dewatering.

The conditioned sludge shall be contained on the belt with adjustable containment barriers equipped with replaceable rubber seals to prevent leakage. Rubber seals are designed to be attached to the containment barriers, with a friction fit, to allow for easy replacement without the use of tools.

The gravity drainage section shall have a minimum thickening area of 66 square feet.

The filter belt, while in the gravity drainage section, shall be supported by a steel grid fitted with high-density polyethylene wiper bars. The wiper bars shall be spaced at a maximum of

two and one half inches and shall have a nominal wear thickness of one half inch, to minimize the frequency of replacement. The wiper bars shall be arranged in a chevron pattern, with the apex toward the sludge inlet, to reduce the possibility of belt creasing. The belt support grid shall be a minimum of 2 inches wider than the belt on each side and so designed to reduce belt wear. Wiper bars constructed of fiberglass, other high friction materials, or table rollers, which require extra maintenance due to coatings, and additional bearings shall not be considered an acceptable substitute to this specification.

The gravity drainage section shall be furnished with chicanes (plows) to adequately furrow the conditioned sludge to facilitate drainage. Each row of chicanes shall be provided with a single lifting handle, designed to remove the entire row of chicanes at least 6 inches from the belt, out of the sludge flow, to facilitate cleaning. Chicanes shall be designed to be individually adjustable laterally and shall pivot to allow them to pass over obstructions on the belt. The minimum of number of chicanes shall be 52, and the minimum number of rows shall be 8.

The gravity drainage zone shall include an adjustable angle ramp assembly. The adjustable ramp shall be provided adjacent to the discharge end of the gravity drainage section which causes the thickened sludge to ascend the ramp prior to discharge. The ramp shall be fitted with a replaceable doctor blade as described in the section titled Doctor Blades elsewhere within this specification. The ramp shall extend across the width of the belt adjacent to the discharge end of the unit and be set at a sufficient height and angle so as to create an optimum backward rolling action of the sludge. The rolling action shall impart a shearing action to the sludge, which further relieves trapped water from between the sludge particles, to enhance and assure optimum thickening.

The ramp assembly shall incorporate the following features:

- 1) The ramp shall be provided with an actuator which includes a manual crank which, when turned, effects the incline of the ramp with respect to the filter belt.
- 2) The ramp adjustment shall be capable of providing inclination angles of between 10 degrees and 45 degrees relative to the filter belt during operation.
- 3) The ramp shall be designed so the location of the leading edge of the doctor blade with respect to the belt remains the same regardless of the angle of inclination at which the ramp is set.
- 4) The ramp assembly shall be capable of being easily and quickly lifted away from the belt and out of the sludge path to facilitate cleaning during operation.
- 5) The angle of inclination of the ramp shall be capable of being adjusted by one person while the unit is in operation and without the use of tools.

All wetted components of the ramp assembly shall be fabricated of Type 316 stainless steel and all other components shall be hot dip galvanized carbon steel.

The gravity drainage section shall incorporate independent belt drive, tracking, and tensioning features which are suitable for the intended service.

2.05 Pressure Section

- A. Each belt filter press shall be furnished with a pressure section following the gravity drainage section. The pressure section shall consist of two stages.

The first stage of the pressure section shall be the increasing pressure (wedge) zone, where the upper and lower belts gradually converge, creating a belt/sludge sandwich. In the wedge zone the sludge cake is prepared for the shear pressure zone by generating continuously increasing pressure on the sludge as it travels through the zone.

For process flexibility, the amount of pressure exerted on the sludge and the rate at which the increasing pressure is applied shall be independently adjustable while the machine is in operation utilizing an adjustable steel wedge plate located between the belts, pressing down on the sludge. These adjustments shall be capable of being performed without causing undue wear on the belts or other components and without causing the belts to be moved from their normal path between rollers. The sludge inlet height at the entrance to the wedge plate shall be adjustable between one and three inches.

The minimum effective dewatering area in the increasing pressure zone shall be 47.9 square feet. The belt in the increasing pressure zone shall be supported in the same manner as supported in the gravity drainage section.

The second stage of the pressure section shall be the shear pressure zone consisting of a 12" radius curved grid and a minimum of eight pressure rollers arranged to provide a serpentine pattern of belt travel.

The curved grid shall further enhance dewatering by causing the pressure on the sludge between the belts to increase and press out free water. The horizontal wiper bars shall give a wiping action to the bottom of the belt in the wedge zone that will quickly remove water from the belt allowing faster drainage. The belt-supporting grid in the wedge zone shall be horizontal for the first several feet and blend into a gradual downward curve, which shall be tangent to the perforated pressure roller that follows.

The first roller in the increasing pressure zone shall be a 16" perforated roller. Rollers shall be constructed as specified under "Rollers". The rollers shall be supported by bearings mounted on the end shafts as specified under "Bearings".

The minimum effective dewatering area in the shear pressure zone shall be 98 square feet. The effective dewatering area in the shear pressure zone shall be defined as the area of curved grid and rollers in contact with the belts, meaning full width of the belt.

2.06 Rollers

- A. All Solid Rollers shall be constructed using one-piece forge shafts and end plates. The forged stub shaft unit shall eliminate all welding of the roller shafts in the region of highest stress where the shafts join with the end plates. Welded up constructions of

round bar and flat plates that create built in stresses and stress concentrations will not be acceptable. The forged stub shaft unit shall be welded to the roller shell with a machine-applied weld using the submerged arc process. The weld depth shall be equal to the wall thickness of the roller shell. The roller shall be machined so that the total indicated runout of the shell relative to the journals is 0.010 inch maximum. Total surface machining is required to provide a smooth surface for the coating of thermoplastic nylon or to prepare the roller for cladding.

The perforated roller, which is the first roller in the pressure section, is designed to allow water to escape out both ends. It shall be constructed with a solid through shaft and at least five (5) radial vanes to support the perforated shell.

The forged stub shaft unit shall be made of ASTM A572 Grade 50 Type 2 or equal. The roller shells may be ASTM A53 or equal. The perforated roller shall have a solid shaft of cold drawn carbon steel, AISC 8620 and the shell and radial vanes shall be ASTM A36 or equal, or stainless steels may be substituted on special order.

Drive rollers shall be coated up to the point of insertion into the bearings by a 1/4-inch minimum thickness of Buna-N rubber. Solid and perforated rollers shall be coated with a 30-mil minimum thickness of thermoplastic nylon.

Solid rollers may also be clad with 304 or 316 stainless steel. The cladding will be welded to the fully machined roller entirely covering the roller up to the point of insertion into the bearings. Welded stainless steel shafts in lieu of the forging are not acceptable for this application due to the lower strength and higher stress.

All solid roller shells shall have a mill spec minimum wall thickness of 1/2 inch. Heavier walls shall be used where required to meet the maximum stress and deflection limits. The roller bearing journals shall be turned to 75 mm to accept direct mounted 75 mm bore bearings. The minimum thickness of the forged flange that forms the end plates shall be one (1) inch.

The perforated roller shall have punched holes of 1 1/4 inch diameter minimum to prevent bridging of solid material. The punched shell shall be rolled with the smooth side out. The shell shall be a minimum 1/4-inch thick.

The rollers shall be analyzed using finite element stress analyses. Certified calculations, showing the maximum stress to be less than 1/5 the yield strength of the material and the maximum deflection at mid span to be less than 0.050 inch shall be submitted as set forth in the contract documents. The standard load case for the pressure rollers shall be a distributed load in the belt contact area equivalent to 50-pli belt tension, weight loading and drive torque. The standard load case for the other rollers shall be a distributed load in the belt contact area equivalent to 50-pli belt tension and weight loading.

2.07 Bearings

- A. All rollers shall be supported by greaseable type, high capacity design roller bearings, in sealed, splash proof, horizontal split case pillow block housings. The bearings shall be direct mounted on the shaft with a shrink fit backed by a retaining snap ring.

Bearings supporting the steering rollers shall be non-self aligning cylindrical roller bearings in pivot mounted pillow block housings.

All other rollers shall be supported by self-aligning Type "E" spherical roller bearings with metallic cages, (plastic cages in spherical roller bearings are not acceptable) mounted in fixed pillow block housings.

Bearings supporting all the rollers except the steering rollers shall be 75mm bore double row spherical bearings (type E construction) AFBMA size number 22215 with a dynamic radial capacity of 41,500 lb.. Bearings supporting the steering rollers shall be 75mm bore single row cylindrical roller bearings AFBMA size number 2215 with a dynamic radial capacity of 36,500 lb.

Bearing housings shall be cast iron with two mounting bolts and four cap bolts. The outer side of the housing shall be solid, without end caps or filler plugs. The housings shall be designed with an integrally cast water trough which, when shrouded by a shaft mounted water flinger, shall divert water from the bearing seal area. The housings shall be cleaned, iron phosphated, and coated with nylon to a thickness of 8-12 mil.

The bearing seal in the pillow block housing shall be of nonmetallic construction with a carrier/flinger, which rotates with the roller shaft. A static sealing arrangement between the carrier/flinger and the shaft shall be a triple rubber seal, constructed in a manner that prevents relative rotation between the seal and the shaft. A dynamic sealing arrangement between the carrier/flinger and the bearing housing shall consist of a primary dynamic contact seal of ozone resistant rubber which shall seal by rotational contact with a machined housing surface. A secondary dynamic seal shall be a labyrinth seal between the carrier/flinger and the bearing housing which utilizes a nonmetallic retaining ring to hold the seal assembly in position within the housing.

Bearing lubrication shall be performed through stainless steel grease fittings mounted on each bearing housing. All bearings shall be outboard (externally mounted) and shall be greaseable while the unit is in operation. Lubrication shall not be required more often than once every six months.

The manufacturer of the belt filter press shall warrant the complete bearing assembly, as specified herein, for a period of five years from the date of start-up, or acceptance of the equipment, whichever occurs first. The warranty shall include all parts and labor for repairing or replacing any bearing that fails during the warranty period.

2.08 Belt Wash System

Each belt filter press shall be equipped with individual belt wash stations for both the upper and lower belts. Each station shall consist of a spray pipe, fitted with spray nozzles, contained within a fabricated housing which encapsulates a section of each belt. The housing and nozzle assembly shall be readily removable.

Nozzle spacing and spray pattern shall be such that the sprays from adjacent nozzles overlap one another at the belt surface. Individual spray nozzles shall be replaceable.

The housing shall be sealed against the belt with rubber seals. The spacing between the upper and lower housing shall be adjustable to insure continuous contact between the seals and belt. The seals shall be replaceable without disassembly of the wash station.

Each belt wash station shall be furnished with a drain valve having an external handwheel to which is mounted a stainless steel cleaning brush located inside the spray pipe. One full turn of the handwheel shall cause the brush bristles to enter each spray nozzle, and dislodge any solid particles which have accumulated, open the valve and allow the solids particles to be flushed into the drainage system.

Belt wash stations shall be the type manufactured by Appleton Manufacturing, Menasha Corporation, Menasha, Wisconsin, the Heinrich Stamm Company, Worms Am Rhein, West Germany, or equal.

Each belt wash station shall be positioned such that the washing is performed after the cake has been discharged from the belt. The belt wash station shall extend over the full width of the filter belt by a minimum of two (2) inches. The belt shall be cleaned by the belt wash with no blinding. The belt wash system shall be suitable for use with plant effluent water supplied at a minimum pressure of 85 psig and shall be designed to operate at a flow of up to 90 gpm.

Washwater pressure shall be supplied to each washwater pump (one required per belt press) at 85 psig, and the belt press manufacturer shall furnish a separately mounted in-line booster pump rated at sufficient capacity and discharge head to meet the process requirements. All controls and equipment necessary to provide a complete operating system shall be provided for the pumps by the belt press manufacturer, including the controls from the machine control panel as specified hereinafter.

Each belt filter press shall be provided with a 1 1/2 inch female pvc connection for belt wash water.

2.09 Belt Alignment System

Each belt shall be provided with an automatic belt alignment system to assure proper alignment of both belts at all times. Belt alignment shall be accomplished using a self-contained system that does not require an external power source, except for electrical power.

The belt alignment system shall be provided with sensing devices designed with a counter-weighted arm fitted with a ceramic plate, which rides on the edge of the belts to detect their position. The arm shall operate a pilot valve, which in turn affects the position of a hydraulic actuator connected to a pivoted belt alignment roller. The pivoting action of the belt alignment roller shall cause this roller to skew from its transverse position to guide the belts centrally along their path.

The alignment systems shall function as a continuous automatic belt guidance system and shall be an integral part of the press. The alignment system shall operate with smooth and slow motions resulting in a minimum of belt travel from side to side. The use of electrical servos or systems which utilize devices that maintain alignment by a large snap action type alternating movement of the alignment roller shall not be considered acceptable to this specification.

Rollers for the belt aligning system shall be constructed as specified under "Rollers". Support bearings for these rollers shall be as specified under "Bearings".

Backup limit switches for the belt alignment system shall be provided on the machine with sufficient contacts to de-energize all drives and sound an alarm in case of belt over-travel.

A hydraulic unit shall be provided, as specified under "Hydraulic Power Unit".

2.10 Belt Tensioning System

Each belt shall be provided with a belt tensioning system. The dewatering belts in the pressure section shall be provided with a tensioning system that is hydraulically actuated. The design of the tensioning system shall be such that adjustments in tension shall result in immediate changes in dewatering pressure.

The belt tensioning system shall be furnished with a control station located on the press so that shutoff of belt tension is possible. Actual belt tension shall be maintained automatically despite process changes or belt stretching and not require additional adjustment by the operator to maintain the set point.

The belt tensioning system shall be designed to accommodate maximum belt stretching during the useful life of the belt.

The tensioning system shall have two hydraulic cylinders for each belt, directly connected to a rigid tensioning yoke, to provide absolute parallel tension across the entire width of the belt. The tension force shall be constant over the full range of the cylinder.

The filter belt in the independent gravity zone shall be provided with a belt tensioning system that is manually operated. The belt shall be furnished with one tension roller.

Rollers for the belt tensioning system shall be constructed as specified under “Rollers”. The ends of the shaft shall be supported by bearings, as specified under “Bearings”. The belt tensioning system shall be designed such that daily adjustment is not required.

Sensing devices shall be furnished for each belt with sufficient electrical contacts to de-energize all drives and sound an alarm in the event of failure of the belt or the tensioning system.

Rollers for the belt tensioning system shall be constructed as specified under "Rollers". The roller shaft bearings shall be as specified under "Bearings".

2.11 Hydraulic Power Unit

Each belt filter press system shall be provided with a dedicated hydraulic power system to provide pressurized oil for the steering and tensioning. The unit shall consist of a one-gallon reservoir; variable-displacement pressure compensated hydraulic oil pump and drive motor, hydraulic oil filter, pressure gauges, piping, valves and cylinders to make a complete operational system.

The pump, motor, reservoir, oil filter and valves shall be mounted directly to the belt press frame to minimize excess piping runs, fittings and hoses. All hydraulic lines shall be properly sized for the pressure and flow of the unit. Pressurized hydraulic lines shall be 316ss tubing and shall be rigidly supported on the structural frame of the press. Flexible lines to cylinders, low-pressure connections to the reservoir, etc. shall be hose of the material and construction appropriate to the application. The hydraulic reservoir shall be made of high-density polyethylene (HDPE) and shall be translucent to allow visual inspection of the oil level.

The pump motor shall be a 1hp and shall not exceed a noise level of 70 DbA. The motor shall be a cast iron TEFC 1,200 rpm, NEMA B design with a “C” face mounting for the hydraulic pump adapter.

Maximum system pressure shall be set equal to the highest pressure required to obtain the desired operating belt tension. The maximum system operating pressure is 1,000 psi.

Hydraulic system controls shall be grouped for easy access and ease of operation. There shall be means provided to retract the belt tension cylinders for service. The valves, fittings, manifold and associated parts shall be of non-corroding materials such as FRP, glass filled Nylon and stainless steel.

The oil pressure gauge(s), one for each pair of belt tension cylinders (upper & lower belt) shall indicate oil pressure in PSI. Low-pressure switch (es) shall be provided to sense the absence of belt tension pressure.

Hydraulic cylinders shall have a non-corrosive body and 316 stainless hardware and cylinder rod. The cylinder rod shall be solid stainless with a hardened polished seal contact

surface. Chrome or nickel-plated rods are not acceptable.

2.12 Belt Drive

- A. Input power to the drive roller shaft shall be supplied through an A.C., variable frequency drive unit. Speed shall be controlled through cyclical variation in motor current, which is operator set at the control panel. The drive roller speed reduction is obtained through a helical gear reducer.

Belt Press Drive Motor Data:

Quantity per Machine	1
Maximum Horsepower	2.0 horsepower
Power Requirements	230/460 v.a.c., 3 phase, 60 cycle.
Rated Speed	1740 r.p.m.
Nema Design	B
Insulation Class	F
Enclosure	TEFC
Service Factor	1.15
Special Features	Severe duty rating

Gravity Zone Drive Motor Data:

Quantity per Machine	1
Maximum Horsepower	2.0 horsepower
Power Requirements	230/460 v.a.c., 3 phase, 60 cycle.
Rated Speed	1800 r.p.m.
Nema Design	B
Insulation Class	F
Enclosure	TEFC
Service Factor	1.15
Special Features	Severe duty rating

The variable input power shall be transmitted through a helical bevel gear reducer connected to the drive roller. The drive roller shall be constructed as specified under "Rollers" and shall be surfaced with a Buna-N rubber coating to permit slip free transmission of driving torque to the belt.

2.13 Dewatering Belts

Each belt filter press shall incorporate the use of three dewatering belts. Belts shall be fabricated of monofilament polyester and shall have 316 Stainless Steel seams. The mesh design shall be selected for optimum dewatering of the sludge to be processed and provide for a 2,000-hour belt life when operated in accordance with the manufacturer's instructions.

Belt selection shall be based on the manufacturer's experience obtained from testing the sludge during start-up of the belt filter press (es) and at other installations dewatering similar sludges with similar polyelectrolyte conditioning chemicals.

Each belt and connecting seam shall be designed for a minimum tensile strength equal to five times the normal maximum dynamic tension to which the belt shall be subjected. The seam shall be designed to fail before the belt.

Belts shall be designed for ease of replacement with a minimum of belt filter down time. Belt replacement shall be such that disassembly of the equipment is not required.

2.14 Discharge Blades

Discharge blades shall be provided to scrape dewatered sludge from the belt at the final discharge rollers. The blades shall be of ultra high molecular weight polyethylene (UHMW) construction and shall be readily removable.

2.15 Drainage Pans

Drainage pans shall be provided as necessary to contain filtrate from all dewatering areas within the belt filter press without splashing and to prevent rewetting of downstream cake. All drainage piping shall be furnished, adequately sized for the intended service, and rigidly attached to the press frame. Drainage piping shall terminate inside the structural frame at the bottom of the press. Drain connection shall be self-venting to prevent overflow. Drainage pans shall be located so that the moving belts do not come into contact with the pans under any condition.

2.16 Control System

Each belt filter press shall be provided with a control panel that will contain the necessary control devices and equipment for controlling the dewatering process as described herein.

GENERAL CONSIDERATIONS

The control panel shall accept a 460 VAC, 60 hertz, 3-phase power input. A main disconnect circuit breaker and operator mechanism shall be included. When the disconnect is in the open position, all power shall be removed from the control system. IEC rated motor starters shall be provided for the hydraulic unit and washwater pump. A VFD will be supplied for the thickener and press belt drive motors. A control power transformer shall be included that will provide 120 VAC control power to the system. All logic functions for the system shall be performed by an industrial grade programmable logic controller (PLC).

Located on the front of the control panel shall be a CONTROL POWER OFF/ON switch. When in the ON position, the CONTROL POWER ON pilot light will be illuminated and control power shall be distributed to the control system. When in the OFF position, the control system shall be held de-energized. Also located on the control panel shall be an EMERGENCY STOP pushbutton. It shall be an illuminated mushroom head style pushbutton that when depressed

shall immediately de-energize all moving equipment in the system. An alarm horn shall be included for audible alarm annunciation.

SYSTEM OPERATION

As a minimum, the following control pilot devices shall be located on the front of the control panel:

- HAND/OFF/AUTO MODE selector switch
- HAND MODE indicator
- AUTO MODE indicator
- AUTO START pushbutton
- AUTO STOP pushbutton
- ALARM SILENCE pushbutton
- SYSTEM RESET pushbutton
- LAMP TEST pushbutton
- PRESS READY indicator
- DEWATERING OFF/ON selector switch
 - WASHDOWN CYCLE ON indicator
- MACHINE MODE BFP/GBT selector
- WASHWATER PUMP START pushbutton
- WASHWATER PUMP STOP pushbutton
- WASHWATER PUMP RUNNING indicator
- HYDRAULIC PUMP START pushbutton
- HYDRAULIC PUMP STOP pushbutton
- HYDRAULIC PUMP RUNNING indicator
- BELT DRIVE START pushbutton
- BELT DRIVE STOP pushbutton
- BELT DRIVE RUNNING indicator
- THICKENER DRIVE SPEED controller (0-100%)
- PRESS BELT DRIVE SPEED controller (0-100%)
- BELT CONVEYOR START pushbutton
- BELT CONVEYOR STOP pushbutton
- BELT CONVEYOR RUNNING indicator
- SLUDGE PUMP START pushbutton
- SLUDGE PUMP STOP pushbutton
- SLUDGE PUMP RUNNING indicator
- SLUDGE PUMP SPEED controller (0-100%)
- POLYMER PUMP START pushbutton
- POLYMER PUMP STOP pushbutton
 - POLYMER PUMP RUNNING indicator
- POLYMER PUMP SPEED controller (0-100%)
- THICKENED SLUDGE PUMP START pushbutton
- THICKENED SLUDGE PUMP STOP pushbutton
- THICKENED SLUDGE PUMP RUNNING indicator
- THICKENED SLUDGE PUMP SPEED controller (0-100%)
- BELT MISALIGNED indicator

BELT BROKEN indicator
LOW WASHWATER PRESSURE indicator
LOW HYDRAULIC PRESSURE indicator
GRAVITY SECTION FAIL / BELT BROKEN indicator
HIGH SLUDGE LEVEL indicator
EMERGENCY STOPPED indicator
PRESS DRIVE FAIL indicator
THICKENER DRIVE FAIL indicator
BELT CONVEYOR FAIL indicator
DISCHARGE HOPPER HIGH LEVEL indicator

The control panel shall require the following discrete signal inputs from others. The signals shall be normally open dry contacts and shall close when the equipment is running.

- a) Belt conveyor running
- b) Sludge pump running
- c) Polymer pump running
- d) Thickened sludge pump running

The control panel shall provide the following discrete signals for use by others. The signals shall be dry contacts.

- a) Press running (N.O. close when running)
- b) Press fault (N.O. close on alarm)
- c) Belt conveyor run (N.O. close to run)
- d) Sludge pump run (N.O. close to run)
- e) Polymer pump run (N.O. close to run)
- f) Thickened sludge pump run (N.O. close to run)

The control panel shall require the following analog signals from others.

- a) Sludge pump speed or flow (4-20 mA)
- b) Polymer pump speed or flow (4-20 mA)
- c) Thickened sludge pump speed or flow (4-20 mA)
- d) Discharge hopper level (4-20 mA)

The control panel shall provide the following analog signals.

- a) Sludge pump speed (4-20 mA)
- b) Polymer pump speed (4-20 mA)
- c) Thickened sludge pump speed (4-20 mA)

SEQUENCE OF OPERATION

The press may be operated in the automatic mode by selecting either dewatering (BFP) or thickening (GBT) mode of operation and then placing the HAND/OFF/AUTO selector switch in the AUTO position. The AUTO MODE indicator will illuminate and the operator will press the AUTO START pushbutton. At this time, the washwater pump, washwater valve and hydraulic pump will be energized and a belt tensioning time delay will start.

After the belt tensioning timer times out, the required belt drive(s) will be energized (only the gravity zone belt drive will start if operating in the GBT mode), the belt conveyor will be energized (if the BFP mode is selected) and a belt pre-wet time delay will start. After the pre-wet timer times out, the PRESS READY pilot light will be illuminated and, if the DEWATERING OFF/ON selector switch is in the ON position, the sludge and polymer pumps will be energized. When the level in the hopper rises, the thickened sludge pump will start.

Pressing the AUTO STOP pushbutton will de-energize the sludge and polymer pumps, illuminate the WASHDOWN ON pilot light and start a wash down time delay. A separate conveyor shutdown timer will energize and after timing out, will de-energize the belt conveyor. After the wash down timer times out, the belt drive, hydraulic pump, washwater pump and washwater valve will be de-energized.

The press may be operated in the manual mode by selecting either dewatering (BFP) or thickening (GBT) mode of operation and then placing the HAND/OFF/AUTO selector switch in the HAND position. The HAND MODE indicator will be illuminated. The operator will start the washwater pump by pressing the WASHWATER PUMP START pushbutton; start the hydraulic pump by pressing the HYDRAULIC PUMP START pushbutton. Anytime the washwater pump is running, the washwater valve shall be energized.

The operator should not proceed until the belts have been fully tensioned. No interlock is provided to prevent the operator from starting the belt drive in the manual mode. Pressing the BELT DRIVE START pushbutton will energize the required belt drive(s) and after a pre-wet time delay will illuminate the PRESS READY pilot light. At this time, the operator will start the belt conveyor by pressing the BELT CONVEYOR START pushbutton, start the sludge pump by pressing the SLUDGE PUMP START pushbutton and start the polymer pump by pressing the POLYMER PUMP START pushbutton. After the sludge level rises in the discharge hopper, the operator may start the thickened sludge pump by pressing the THICKENED SLUDGE PUMP START pushbutton.

Pressing the respective STOP pushbutton in the reverse order stated above will stop the system.

FAULTS

When any of the following fault conditions occur, in automatic or manual mode, the appropriate fault indicator will be illuminated, the alarm horn will sound and the belt filter press and associated equipment will be de-energized.

EMERGENCY STOP
BELT MISALIGNED
BELT BROKEN
LOW WASHWATER PRESSURE
HYDRAULIC PRESSURE FAULT
GRAVITY SECTION FAIL / BELT BROKEN
THICKENER DRIVE FAIL
PRESS DRIVE FAIL

BELT CONVEYOR FAIL

ENCLOSURES

Control panel enclosures shall be fabricated of type 304 stainless steel and shall be suitable for NEMA 4X service. Enclosures shall be manufactured by Hoffman Manufacturing, Steeline or equal.

WIRING

All power and control wiring shall be 600 volt, type THHN/THWN or MTW insulation stranded copper and shall be sized for the required load, 14 AWG minimum.

CIRCUIT BREAKERS

The circuit breaker for the main disconnect shall be thermal magnetic molded case units. The circuit breaker shall be Square D FAL type or equal.

MOTOR STARTERS

Motor starters shall be full voltage, non-reversing, IEC style across-the-line units. Coils shall be 120 VAC. The starters shall be Allen Bradley style 140M w/100 contactors.

SPEED CONTROLLERS

The speed controllers shall be capable of outputting a 4-20ma DC or 0-10v DC setpoint control signal and accept a 4-20ma DC or 0-10v DC status signal. The controller shall be capable of PID control. The controller shall be Red Lion P48 or equal.

SELECTOR SWITCHES

All selector switches shall be heavy duty, oil tight/watertight, corrosion resistant units rated for NEMA 4X service. Contact blocks shall be rated for 10-ampere continuous service. Selector switches shall be Allen Bradley Type 800H or equal.

PUSHBUTTONS

All pushbuttons shall be heavy duty, oil tight/watertight, corrosion resistant units rated for NEMA 4X service. Contact blocks shall be rated for 10-ampere continuous service. Pushbuttons shall be Allen Bradley Type 800H or equal.

PILOT LIGHTS

Pilot lights shall be heavy duty, oil tight/watertight, corrosion resistant units rated for NEMA 4X service. Units shall be 120 VAC transformer type. Pilot lights shall be Allen Bradley Type 800H or equal.

TERMINAL BLOCKS

Terminal blocks shall be high density, spring cage clamp style, with 600 volt rating. Terminal blocks shall be WAGO, Class 280, Type M, or equal.

PROGRAMMABLE LOGIC CONTROLLER

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The PLC shall be a modular type with discrete and analog capabilities. The CPU shall have 4K minimum RAM for user instructions. The unit shall have battery backed RAM and EEPROM backup. The PLC shall be an Allen Bradley Compact Logix or equal.

VARIABLE FREQUENCY DRIVE (VFD)

The VFDs shall be UL listed and shall be Allen Bradley Powerflex style or approved equal.

2.17 Spare Parts

The following spare parts shall be furnished with the belt filter presses:

1. One set of filter belts for each press supplied.
2. Two complete sets of doctor blades for each press supplied.
3. One of each size and type of roller bearing complete.
4. Two complete sets of rubber seals for each press supplied.

PART 3 MANUFACTURER'S SERVICES

3.01 Start-up and Operator Training

Services of the manufacturer's factory trained representative, who is specifically knowledgeable in the type of equipment specified herein, shall be provided during the equipment installation period. Upon complete installation of equipment by installing contractor, including placement of equipment, setting and leveling the equipment, piping and electrical connections to all the equipment specified herein, the manufacturer's service representative will approve the installation and begin start up and training.

Upon approval of the installation, the services of the manufacturer's factory trained representative shall be provided at the project site for equipment start-up and calibration. During the start-up and calibration phase the manufacturer's representative shall inspect all system components for proper connection and alignment and assist the installation contractor in placing the equipment in a proper operating condition.

Upon satisfactory completion of the start-up and calibration, a representative of the manufacturer shall be provided to instruct Owner's personnel in the proper operation and maintenance of the equipment. The manufacturer's representative who will be providing the instruction shall have prior operation, maintenance and instructing experience acceptable to the Engineer. The contractor shall submit the individual's name and qualifications to the Engineer for approval at least one week prior to the scheduled operating and maintenance instruction sessions. The number of days listed below for services of the manufacturer's factory trained representative shall be provided when requested by the Owner or the Engineer during the contract period.

The manufacturer's representative shall complete all of the above sessions in a total of two trips to the jobsite. The equipment manufacturer will request in writing that all installation prior to arriving at the jobsite be completed by the contractor. If the equipment manufacturer arrives at the jobsite and equipment installation is not complete, the equipment manufacturer shall bill the

contractor at the manufacturer's standard service rates, or as agreed to at the time of the service request.

Period	Number of 8-hour days
Inspection / Start Up and Calibration	4
Operator Training	2

- All times listed are per unit.

Additional services, other than those provided for by warranties or as specified herein, may be charged to the Owner/Contractor at the manufacturer's standard service rates or as agreed to at the time of the service request.

END OF SECTION

equipment supplied under this contract, but without the right to grant sublicenses.

1.05 Warranty

A. The manufacturer shall warrant, in writing, that all equipment supplied by them shall be free from defects in material and workmanship, for a period of twelve (12) months from the date of start up, not to exceed eighteen (18) months from the date of delivery, unless noted otherwise within the specifications.

1.06 Conditions of Service

A. The sludge dewatering equipment shall be designed to adequately condition and dewater the sludge such that a dewatered sludge cake is produced that easily discharges from the dewatering unit, without blinding, and that may be handled by the conveying equipment.

Each unit shall be designed to operate in the environment for which it is intended, continuously or intermittently on demand, and shall perform the required dewatering operations without spillage of water or sludge beyond the nominal machine envelope.

The description of the sludge to be fed to the belt filter press is as follows:

Type of sludge: digested waste activated
Feed Solids, percent d.w.s.: 2%

1.07 Quality Assurance

A. System Responsibility: Vested responsibility for operation and control of the BFP system, which is comprised of all equipment controlled by the BFP control panel, is the BFP manufacturers.

B. Experience Qualification: A qualified manufacturer is one having a minimum of ten (10) units of the proposed model, each having been in operation for a period of not less than five (5) years.

C. The belt filter press manufacturer is to have a minimum 20 years of development, assembly and manufacturing experience. No exceptions to this requirement shall be accepted.

D. Source Quality Control: The belt filter press shall be designed, fabricated, assembled, and tested by the belt filter press manufacturer in their own facility. In order to provide maximum quality assurance, all aspects of the design, fabrication, and assembly, shall be performed by personnel employed by the manufacturer. The belt filter press manufacturer shall at the same facility

maintain a suitable spare parts inventory.

E. Factory Quality Control Test: Prior to shipment, the belt filter press and control panel shall be factory tested at the place of assembly. Factory test each pre-assembled, pre-wired, lubricated, and aligned BFP and its associated control panel to be supplied to the job site. Prior to shipment, verify through a one-hour continuous operating test that the BFP and associated equipment operate smoothly, noiselessly, vibration free, and without overheating of any bearing or motor. Particular attention must be given to assure that the BFP is properly aligned for maintaining the centerline-to-centerline tracking of the belts relative to the machine. Submit a certified test report to the Engineer for approval, prior to shipping that demonstrates compliance with all applicable industry standards, manufacturing quality control, and the functional intent of these Specifications.

F. The owner/engineer shall, at their option, be permitted to witness the factory quality control test at the manufacturer's facility. The manufacturer shall give the owner/engineer a minimum of two- (2) weeks notice prior to testing.

G. Belt Filter Press shall be manufactured by:

1. Alfa Laval
2. Charter Machine Company
3. Engineer Approved Equal

PART II - MECHANICAL REQUIREMENTS

2.01 Materials and Coatings

A. All materials used in the construction of the sludge dewatering equipment shall be of the best quality and entirely suitable in every respect for the service required. All structural steel shall conform to the latest ASTM Standard Specification for Structural Steel, Designation A36/A36M-93b. All iron castings shall conform to the latest Standard Specifications for Gray Iron Castings, and shall be of a class suitable for the purpose intended. Other materials shall conform to the ASTM Specifications where such specifications exist; the use of such materials shall be based on continuous and successful use under similar conditions of service.

All electrical components shall be U.L. listed where such listing exists and all electrical control panels shall be assembled in U.L. approved facilities. All structural carbon steel plates and shapes shall have a minimum thickness of 1/4 inch and shall be hot dip galvanized in accordance with ASTM A-123.

All structural carbon steel plates and shapes shall have a minimum thickness of 1/4 inch and shall be hot dip galvanized in accordance with ASTM A-123.

Unless specified otherwise herein, all metals in contact with polyelectrolyte or sludge, and all other components specified to be stainless steel, shall be type 316L

stainless steel.

The following materials and coatings shall be provided for the belt filter press and related components unless specified otherwise herein:

Bearing housings	Nylon coated, cast iron
Belt support grids	Stainless steel, fitted with UHMW polyethylene wiper bars
Belt wash housing	Stainless steel, 14 gauge.
Belt wash spray tube and nozzles	Stainless steel.
Belt wash piping	Schedule 80 PVC, 1 1/2 inch.
Chicanes	Galvanized steel support rods, galvanized cast iron holders and U.H.M.W. polyethylene blades.
Chutes (feed and discharge) (if required)	Stainless steel, 10 gauge.
Doctor blades	U.H.M.W. polyethylene.
Drain trays	Stainless steel, 14 gauge.
Drain tray piping	Schedule 40 PVC.
Electrical junction box	Stainless steel or FRP
Electrical conduit	SO Cord
Electrical switch enclosures	NEMA 4, press mounted
Frame	A36 steel, hot dip galvanized, ASTM A123, minimum 3.9 mils.
Hardware, fasteners, springs, clips, etc.	316 stainless steel.
Hydraulic cylinders:	
body:	FRP tube with high strength glass filled
nylon head	
rod:	Solid 316 stainless steel with hard surface treatment

Miscellaneous	Carbon steel surfaces to be hot dipped galvanized per ASTM A123
Polymer mixer housing	Cast 316ss Counterweight Cast iron, galvanized Injection ring UHMW polyethylene Splitter Manifold UHMW polyethylene
Rollers (solid)	Carbon steel, 1/2 -inch wall,. Drive rollers coated with Buna N rubber, 1/4 inch, other solid rollers coated with thermoplastic nylon, 25 mils.
Rollers (perforated)	1/4 -inch wall carbon steel hot dip galvanized, or nylon coated
Roller shafts	Forged steel ASTM 572 Grade 50, perforated roller shall have 8620
Sludge containment barriers	Stainless steel, 14 gauge.

B. All hot dip galvanizing shall be applied in accordance with ASTM-A123 minimum 5-7 mil. Zinc flame spray shall not be considered an acceptable substitute to this specification.

Coating Properties	Test Method	Value
Hardness, Shore D	ASTM D-224077	
Specific Gravity	ASTM D-7921.06-1.20	
Impact, RT & 45 F	ASTM D-2794160 in lbs	
Direct Pass		
Tensile Strength	ASTM D-6386000 PSI	
Elongation	ASTM D-63815%	
Melting Point	ASTM D-789370°F	
Abrasion Resistance (varies with color)	ASTM D-40608-18 mg. Wt. loss CS17/1000/1000	Taper Abrader)

Buna N rubber coating shall have the following properties:

Tensile strength, ASTM D-412	2500 psi
Tear strength, die C, ASTM D-624	250 psi
Elongation at break, ASTM D-412	160%
Hardness, Shore A, ASTM D -676 90	

2.02 Sludge Conditioning System

A. Each belt filter press shall be provided with a sludge conditioning system, designed to efficiently mix polymer with the sludge and to adequately flocculate the sludge,

for optimum dewatering.

The sludge conditioning system shall be mounted upstream of the press and shall consist of an inline adjustable orifice venturi type mixer complete with polymer injection device.

The belt filter press manufacturer shall be required to provide, to the engineer, a proper layout for the system.

The sludge conditioning system shall be capable of providing the following performance:

- 1) The polymer and sludge must be instantly mixed (less than 1.0 seconds at 60 GPM).
- 2) Mixing energy must be independently adjustable during operation.
- 3) Flocculation time must be independently adjustable, by the displacement of flanged pipe sections, with the mixer, at a minimum of two locations in the sludge feed piping.
- 4) Magnetic flow meter accurately installed on the discharge line to the gravity section of the Belt Filter Press.

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The sludge conditioning system shall meet the following mechanical specifications:

- 1) The in-line mixer shall have a flanged housing, an adjustable orifice plate, with shaft and o-ring seal, connected to an externally mounted lever and counterweight and a removable side plate for inspection and cleaning.
- 2) The open throat area of the mixer shall be fully adjustable downward and shall open automatically to prevent clogging.
- 3) The position of the counterweight on the externally mounted orifice plate lever shall be fully adjustable, within a 360 degree circle, to allow for adjustment of the mixing energy, regardless of mounting angle, while the unit is in operation.

The polymer mixer shall be designed specifically for its intended use. The use of modified check valves, static mixers, or mixers requiring a tank and motor driven propeller shall not be acceptable to this specification.

2.03 Structural Main Frame

A. The structural main frame shall be fabricated of steel members conforming to AISC Standard Specifications for Structural Steel, into a rigid structure, adequately braced to

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withstand intended loads without excessive vibration or deflection.

The frame shall have a minimum safety factor of > 5 and maximum deflection of 0.011 inches under maximum loading. The moment of inertia of the structural members shall be adequately chosen to provide the safety factor and deflection rate specified herein.

Maximum load on the frame shall be based on the summation of forces applied to the frame from roller mass forces, weight of the rollers including the sludge and belts and belt tension forces. Belt tension forces shall include, but not be limited to, a belt tension of 50 pli per belt plus the tension produced by the driving torque of the motor at nameplate ph. Certified calculations, showing the frame to be in compliance with the specification, shall be submitted as set forth in the contract documents.

The framework shall be of welded and/or bolted construction. All welding shall conform to the American Welding Society Structural Welding Code.

The structure shall be designed for installation on a prepared concrete foundation and secured with anchor bolts. Permanent lifting lugs shall be provided as necessary to allow installation and removal of the belt filter press.

The construction shall allow easy access and visual inspection of all internal components.

The manufacturer shall warrant the frame and the coating for a period of three years from the date of start-up, not to exceed three and a half years from the date of delivery. The frame shall not require preventive maintenance during the warranty period. Any defects or corrosion occurring within the warranty period shall be repaired or replaced at no additional cost to the owner.

2.04 Gravity Drainage Section

A. Each belt filter press shall be furnished with an independent gravity drainage section to accept sludge from the sludge conditioning system. The gravity drainage section shall be furnished with a sludge feed chute and an inlet distributor to evenly distribute the conditioned sludge over the effective width of the moving filter belt. The independent gravity drainage section shall be designed so that it can be operated, on demand, as either just a thickening device only or as a pre-thickening device prior to dewatering.

The conditioned sludge shall be contained on the belt with adjustable containment barriers equipped with replaceable rubber seals to prevent leakage. Rubber seals are designed to be attached to the containment barriers, with a friction fit, to allow for easy replacement without the use of tools.

The gravity drainage section shall have a minimum thickening area of 66 square feet.

The filter belt, while in the gravity drainage section, shall be supported by a steel grid fitted with high-density polyethylene wiper bars. The wiper bars shall be spaced at a maximum of

two and one half inches and shall have a nominal wear thickness of one half inch, to minimize the frequency of replacement. The wiper bars shall be arranged in a chevron pattern, with the apex toward the sludge inlet, to reduce the possibility of belt creasing. The belt support grid shall be a minimum of 2 inches wider than the belt on each side and so designed to reduce belt wear. Wiper bars constructed of fiberglass, other high friction materials, or table rollers, which require extra maintenance due to coatings, and additional bearings shall not be considered an acceptable substitute to this specification.

The gravity drainage section shall be furnished with chicanes (plows) to adequately furrow the conditioned sludge to facilitate drainage. Each row of chicanes shall be provided with a single lifting handle, designed to remove the entire row of chicanes at least 6 inches from the belt, out of the sludge flow, to facilitate cleaning. Chicanes shall be designed to be individually adjustable laterally and shall pivot to allow them to pass over obstructions on the belt. The minimum of number of chicanes shall be 52, and the minimum number of rows shall be 8.

The gravity drainage zone shall include an adjustable angle ramp assembly. The adjustable ramp shall be provided adjacent to the discharge end of the gravity drainage section which causes the thickened sludge to ascend the ramp prior to discharge. The ramp shall be fitted with a replaceable doctor blade as described in the section titled Doctor Blades elsewhere within this specification. The ramp shall extend across the width of the belt adjacent to the discharge end of the unit and be set at a sufficient height and angle so as to create an optimum backward rolling action of the sludge. The rolling action shall impart a shearing action to the sludge, which further relieves trapped water from between the sludge particles, to enhance and assure optimum thickening.

The ramp assembly shall incorporate the following features:

- 1) The ramp shall be provided with an actuator which includes a manual crank which, when turned, effects the incline of the ramp with respect to the filter belt.
- 2) The ramp adjustment shall be capable of providing inclination angles of between 10 degrees and 45 degrees relative to the filter belt during operation.
- 3) The ramp shall be designed so the location of the leading edge of the doctor blade with respect to the belt remains the same regardless of the angle of inclination at which the ramp is set.
- 4) The ramp assembly shall be capable of being easily and quickly lifted away from the belt and out of the sludge path to facilitate cleaning during operation.
- 5) The angle of inclination of the ramp shall be capable of being adjusted by one person while the unit is in operation and without the use of tools.

All wetted components of the ramp assembly shall be fabricated of Type 316 stainless steel and all other components shall be hot dip galvanized carbon steel.

The gravity drainage section shall incorporate independent belt drive, tracking, and tensioning features which are suitable for the intended service.

2.05 Pressure Section

- A. Each belt filter press shall be furnished with a pressure section following the gravity drainage section. The pressure section shall consist of two stages.

The first stage of the pressure section shall be the increasing pressure (wedge) zone, where the upper and lower belts gradually converge, creating a belt/sludge sandwich. In the wedge zone the sludge cake is prepared for the shear pressure zone by generating continuously increasing pressure on the sludge as it travels through the zone.

For process flexibility, the amount of pressure exerted on the sludge and the rate at which the increasing pressure is applied shall be independently adjustable while the machine is in operation utilizing an adjustable steel wedge plate located between the belts, pressing down on the sludge. These adjustments shall be capable of being performed without causing undue wear on the belts or other components and without causing the belts to be moved from their normal path between rollers. The sludge inlet height at the entrance to the wedge plate shall be adjustable between one and three inches.

The minimum effective dewatering area in the increasing pressure zone shall be 47.9 square feet. The belt in the increasing pressure zone shall be supported in the same manner as supported in the gravity drainage section.

The second stage of the pressure section shall be the shear pressure zone consisting of a 12" radius curved grid and a minimum of eight pressure rollers arranged to provide a serpentine pattern of belt travel.

The curved grid shall further enhance dewatering by causing the pressure on the sludge between the belts to increase and press out free water. The horizontal wiper bars shall give a wiping action to the bottom of the belt in the wedge zone that will quickly remove water from the belt allowing faster drainage. The belt-supporting grid in the wedge zone shall be horizontal for the first several feet and blend into a gradual downward curve, which shall be tangent to the perforated pressure roller that follows.

The first roller in the increasing pressure zone shall be a 16" perforated roller. Rollers shall be constructed as specified under "Rollers". The rollers shall be supported by bearings mounted on the end shafts as specified under "Bearings".

The minimum effective dewatering area in the shear pressure zone shall be 98 square feet. The effective dewatering area in the shear pressure zone shall be defined as the area of curved grid and rollers in contact with the belts, meaning full width of the belt.

2.06 Rollers

- A. All Solid Rollers shall be constructed using one-piece forge shafts and end plates. The forged stub shaft unit shall eliminate all welding of the roller shafts in the region of highest stress where the shafts join with the end plates. Welded up constructions of

round bar and flat plates that create built in stresses and stress concentrations will not be acceptable. The forged stub shaft unit shall be welded to the roller shell with a machine-applied weld using the submerged arc process. The weld depth shall be equal to the wall thickness of the roller shell. The roller shall be machined so that the total indicated runout of the shell relative to the journals is 0.010 inch maximum. Total surface machining is required to provide a smooth surface for the coating of thermoplastic nylon or to prepare the roller for cladding.

The perforated roller, which is the first roller in the pressure section, is designed to allow water to escape out both ends. It shall be constructed with a solid through shaft and at least five (5) radial vanes to support the perforated shell.

The forged stub shaft unit shall be made of ASTM A572 Grade 50 Type 2 or equal. The roller shells may be ASTM A53 or equal. The perforated roller shall have a solid shaft of cold drawn carbon steel, AISC 8620 and the shell and radial vanes shall be ASTM A36 or equal, or stainless steels may be substituted on special order.

Drive rollers shall be coated up to the point of insertion into the bearings by a 1/4-inch minimum thickness of Buna-N rubber. Solid and perforated rollers shall be coated with a 30-mil minimum thickness of thermoplastic nylon.

Solid rollers may also be clad with 304 or 316 stainless steel. The cladding will be welded to the fully machined roller entirely covering the roller up to the point of insertion into the bearings. Welded stainless steel shafts in lieu of the forging are not acceptable for this application due to the lower strength and higher stress.

All solid roller shells shall have a mill spec minimum wall thickness of 1/2 inch. Heavier walls shall be used where required to meet the maximum stress and deflection limits. The roller bearing journals shall be turned to 75 mm to accept direct mounted 75 mm bore bearings. The minimum thickness of the forged flange that forms the end plates shall be one (1) inch.

The perforated roller shall have punched holes of 1 1/4 inch diameter minimum to prevent bridging of solid material. The punched shell shall be rolled with the smooth side out. The shell shall be a minimum 1/4-inch thick.

The rollers shall be analyzed using finite element stress analyses. Certified calculations, showing the maximum stress to be less than 1/5 the yield strength of the material and the maximum deflection at mid span to be less than 0.050 inch shall be submitted as set forth in the contract documents. The standard load case for the pressure rollers shall be a distributed load in the belt contact area equivalent to 50-pli belt tension, weight loading and drive torque. The standard load case for the other rollers shall be a distributed load in the belt contact area equivalent to 50-pli belt tension and weight loading.

2.07 Bearings

- A. All rollers shall be supported by greaseable type, high capacity design roller bearings, in sealed, splash proof, horizontal split case pillow block housings. The bearings shall be direct mounted on the shaft with a shrink fit backed by a retaining snap ring.

Bearings supporting the steering rollers shall be non-self aligning cylindrical roller bearings in pivot mounted pillow block housings.

All other rollers shall be supported by self-aligning Type "E" spherical roller bearings with metallic cages, (plastic cages in spherical roller bearings are not acceptable) mounted in fixed pillow block housings.

Bearings supporting all the rollers except the steering rollers shall be 75mm bore double row spherical bearings (type E construction) AFBMA size number 22215 with a dynamic radial capacity of 41,500 lb.. Bearings supporting the steering rollers shall be 75mm bore single row cylindrical roller bearings AFBMA size number 2215 with a dynamic radial capacity of 36,500 lb.

Bearing housings shall be cast iron with two mounting bolts and four cap bolts. The outer side of the housing shall be solid, without end caps or filler plugs. The housings shall be designed with an integrally cast water trough which, when shrouded by a shaft mounted water flinger, shall divert water from the bearing seal area. The housings shall be cleaned, iron phosphated, and coated with nylon to a thickness of 8-12 mil.

The bearing seal in the pillow block housing shall be of nonmetallic construction with a carrier/flinger, which rotates with the roller shaft. A static sealing arrangement between the carrier/flinger and the shaft shall be a triple rubber seal, constructed in a manner that prevents relative rotation between the seal and the shaft. A dynamic sealing arrangement between the carrier/flinger and the bearing housing shall consist of a primary dynamic contact seal of ozone resistant rubber which shall seal by rotational contact with a machined housing surface. A secondary dynamic seal shall be a labyrinth seal between the carrier/flinger and the bearing housing which utilizes a nonmetallic retaining ring to hold the seal assembly in position within the housing.

Bearing lubrication shall be performed through stainless steel grease fittings mounted on each bearing housing. All bearings shall be outboard (externally mounted) and shall be greaseable while the unit is in operation. Lubrication shall not be required more often than once every six months.

The manufacturer of the belt filter press shall warrant the complete bearing assembly, as specified herein, for a period of five years from the date of start-up, or acceptance of the equipment, whichever occurs first. The warranty shall include all parts and labor for repairing or replacing any bearing that fails during the warranty period.

2.08 Belt Wash System

Each belt filter press shall be equipped with individual belt wash stations for both the upper and lower belts. Each station shall consist of a spray pipe, fitted with spray nozzles, contained within a fabricated housing which encapsulates a section of each belt. The housing and nozzle assembly shall be readily removable.

Nozzle spacing and spray pattern shall be such that the sprays from adjacent nozzles overlap one another at the belt surface. Individual spray nozzles shall be replaceable.

The housing shall be sealed against the belt with rubber seals. The spacing between the upper and lower housing shall be adjustable to insure continuous contact between the seals and belt. The seals shall be replaceable without disassembly of the wash station.

Each belt wash station shall be furnished with a drain valve having an external handwheel to which is mounted a stainless steel cleaning brush located inside the spray pipe. One full turn of the handwheel shall cause the brush bristles to enter each spray nozzle, and dislodge any solid particles which have accumulated, open the valve and allow the solids particles to be flushed into the drainage system.

Belt wash stations shall be the type manufactured by Appleton Manufacturing, Menasha Corporation, Menasha, Wisconsin, the Heinrich Stamm Company, Worms Am Rhein, West Germany, or equal.

Each belt wash station shall be positioned such that the washing is performed after the cake has been discharged from the belt. The belt wash station shall extend over the full width of the filter belt by a minimum of two (2) inches. The belt shall be cleaned by the belt wash with no blinding. The belt wash system shall be suitable for use with plant effluent water supplied at a minimum pressure of 85 psig and shall be designed to operate at a flow of up to 90 gpm.

Washwater pressure shall be supplied to each washwater pump (one required per belt press) at 85 psig, and the belt press manufacturer shall furnish a separately mounted in-line booster pump rated at sufficient capacity and discharge head to meet the process requirements. All controls and equipment necessary to provide a complete operating system shall be provided for the pumps by the belt press manufacturer, including the controls from the machine control panel as specified hereinafter.

Each belt filter press shall be provided with a 1 1/2 inch female pvc connection for belt wash water.

2.09 Belt Alignment System

Each belt shall be provided with an automatic belt alignment system to assure proper alignment of both belts at all times. Belt alignment shall be accomplished using a self-contained system that does not require an external power source, except for electrical power.

The belt alignment system shall be provided with sensing devices designed with a counter-weighted arm fitted with a ceramic plate, which rides on the edge of the belts to detect their position. The arm shall operate a pilot valve, which in turn affects the position of a hydraulic actuator connected to a pivoted belt alignment roller. The pivoting action of the belt alignment roller shall cause this roller to skew from its transverse position to guide the belts centrally along their path.

The alignment systems shall function as a continuous automatic belt guidance system and shall be an integral part of the press. The alignment system shall operate with smooth and slow motions resulting in a minimum of belt travel from side to side. The use of electrical servos or systems which utilize devices that maintain alignment by a large snap action type alternating movement of the alignment roller shall not be considered acceptable to this specification.

Rollers for the belt aligning system shall be constructed as specified under "Rollers". Support bearings for these rollers shall be as specified under "Bearings".

Backup limit switches for the belt alignment system shall be provided on the machine with sufficient contacts to de-energize all drives and sound an alarm in case of belt over-travel.

A hydraulic unit shall be provided, as specified under "Hydraulic Power Unit".

2.10 Belt Tensioning System

Each belt shall be provided with a belt tensioning system. The dewatering belts in the pressure section shall be provided with a tensioning system that is hydraulically actuated. The design of the tensioning system shall be such that adjustments in tension shall result in immediate changes in dewatering pressure.

The belt tensioning system shall be furnished with a control station located on the press so that shutoff of belt tension is possible. Actual belt tension shall be maintained automatically despite process changes or belt stretching and not require additional adjustment by the operator to maintain the set point.

The belt tensioning system shall be designed to accommodate maximum belt stretching during the useful life of the belt.

The tensioning system shall have two hydraulic cylinders for each belt, directly connected to a rigid tensioning yoke, to provide absolute parallel tension across the entire width of the belt. The tension force shall be constant over the full range of the cylinder.

The filter belt in the independent gravity zone shall be provided with a belt tensioning system that is manually operated. The belt shall be furnished with one tension roller.

Rollers for the belt tensioning system shall be constructed as specified under "Rollers". The ends of the shaft shall be supported by bearings, as specified under "Bearings". The belt tensioning system shall be designed such that daily adjustment is not required.

Sensing devices shall be furnished for each belt with sufficient electrical contacts to de-energize all drives and sound an alarm in the event of failure of the belt or the tensioning system.

Rollers for the belt tensioning system shall be constructed as specified under "Rollers". The roller shaft bearings shall be as specified under "Bearings".

2.11 Hydraulic Power Unit

Each belt filter press system shall be provided with a dedicated hydraulic power system to provide pressurized oil for the steering and tensioning. The unit shall consist of a one-gallon reservoir; variable-displacement pressure compensated hydraulic oil pump and drive motor, hydraulic oil filter, pressure gauges, piping, valves and cylinders to make a complete operational system.

The pump, motor, reservoir, oil filter and valves shall be mounted directly to the belt press frame to minimize excess piping runs, fittings and hoses. All hydraulic lines shall be properly sized for the pressure and flow of the unit. Pressurized hydraulic lines shall be 316ss tubing and shall be rigidly supported on the structural frame of the press. Flexible lines to cylinders, low-pressure connections to the reservoir, etc. shall be hose of the material and construction appropriate to the application. The hydraulic reservoir shall be made of high-density polyethylene (HDPE) and shall be translucent to allow visual inspection of the oil level.

The pump motor shall be a 1hp and shall not exceed a noise level of 70 DbA. The motor shall be a cast iron TEFC 1,200 rpm, NEMA B design with a "C" face mounting for the hydraulic pump adapter. Maximum system pressure shall be set equal to the highest pressure required to obtain the desired operating belt tension. The maximum system operating pressure is 1,000 psi.

Hydraulic system controls shall be grouped for easy access and ease of operation. There shall be means provided to retract the belt tension cylinders for service. The valves, fittings, manifold and associated parts shall be of non-corroding materials such as FRP, glass filled Nylon and stainless steel.

The oil pressure gauge(s), one for each pair of belt tension cylinders (upper & lower belt) shall indicate oil pressure in PSI. Low-pressure switch (es) shall be provided to sense the absence of belt tension pressure.

Hydraulic cylinders shall have a non-corrosive body and 316 stainless hardware and cylinder rod. The cylinder rod shall be solid stainless with a hardened polished seal contact

surface. Chrome or nickel-plated rods are not acceptable.

2.12 Belt Drive

- A. Input power to the drive roller shaft shall be supplied through an A.C., variable frequency drive unit. Speed shall be controlled through cyclical variation in motor current, which is operator set at the control panel. The drive roller speed reduction is obtained through a helical gear reducer.

Belt Press Drive Motor Data:

Quantity per Machine	1
Maximum Horsepower	2.0 horsepower
Power Requirements	230/460 v.a.c., 3 phase, 60 cycle.
Rated Speed	1740 r.p.m.
Nema Design	B
Insulation Class	F
Enclosure	TEFC
Service Factor	1.15
Special Features	Severe duty rating

Gravity Zone Drive Motor Data:

Quantity per Machine	1
Maximum Horsepower	2.0 horsepower
Power Requirements	230/460 v.a.c., 3 phase, 60 cycle.
Rated Speed	1800 r.p.m.
Nema Design	B
Insulation Class	F
Enclosure	TEFC
Service Factor	1.15
Special Features	Severe duty rating

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The variable input power shall be transmitted through a helical bevel gear reducer connected to the drive roller. The drive roller shall be constructed as specified under "Rollers" and shall be surfaced with a Buna-N rubber coating to permit slip free transmission of driving torque to the belt.

2.13 Dewatering Belts

Each belt filter press shall incorporate the use of three dewatering belts. Belts shall be fabricated of monofilament polyester and shall have 316 Stainless Steel seams. The mesh design shall be selected for optimum dewatering of the sludge to be processed and provide for a 2,000-hour belt life when operated in accordance with the manufacturer's instructions.

Belt selection shall be based on the manufacturer's experience obtained from testing the sludge during start-up of the belt filter press (es) and at other installations dewatering similar sludges with similar polyelectrolyte conditioning chemicals.

Each belt and connecting seam shall be designed for a minimum tensile strength equal to five times the normal maximum dynamic tension to which the belt shall be subjected. The seam shall be designed to fail before the belt.

Belts shall be designed for ease of replacement with a minimum of belt filter down time. Belt replacement shall be such that disassembly of the equipment is not required.

2.14 Discharge Blades

Discharge blades shall be provided to scrape dewatered sludge from the belt at the final discharge rollers. The blades shall be of ultra high molecular weight polyethylene (UHMW) construction and shall be readily removable.

2.15 Drainage Pans

Drainage pans shall be provided as necessary to contain filtrate from all dewatering areas within the belt filter press without splashing and to prevent rewetting of downstream cake. All drainage piping shall be furnished, adequately sized for the intended service, and rigidly attached to the press frame. Drainage piping shall terminate inside the structural frame at the bottom of the press. Drain connection shall be self-venting to prevent overflow. Drainage pans shall be located so that the moving belts do not come into contact with the pans under any condition.

2.16 Control System

Each belt filter press shall be provided with a control panel that will contain the necessary control devices and equipment for controlling the dewatering process as described herein.

GENERAL CONSIDERATIONS

The control panel shall accept a 460 VAC, 60 hertz, 3-phase power input. A main disconnect circuit breaker and operator mechanism shall be included. When the disconnect is in the open position, all power shall be removed from the control system. IEC rated motor starters shall be provided for the hydraulic unit and washwater pump. A VFD will be supplied for the thickener and press belt drive motors. A control power transformer shall be included that will provide 120 VAC control power to the system. All logic functions for the system shall be performed by an industrial grade programmable logic controller (PLC).

Located on the front of the control panel shall be a CONTROL POWER OFF/ON switch. When in the ON position, the CONTROL POWER ON pilot light will be illuminated and control power shall be distributed to the control system. When in the OFF position, the control system shall be held de-energized. Also located on the control panel shall be an EMERGENCY STOP pushbutton. It shall be an illuminated mushroom head style pushbutton that when depressed

shall immediately de-energize all moving equipment in the system. An alarm horn shall be included for audible alarm annunciation.

SYSTEM OPERATION

As a minimum, the following control pilot devices shall be located on the front of the control panel:

- HAND/OFF/AUTO MODE selector switch
- HAND MODE indicator
- AUTO MODE indicator
- AUTO START pushbutton
- AUTO STOP pushbutton
- ALARM SILENCE pushbutton
- SYSTEM RESET pushbutton
- LAMP TEST pushbutton
- PRESS READY indicator
- DEWATERING OFF/ON selector switch
 - WASHDOWN CYCLE ON indicator
- MACHINE MODE BFP/GBT selector
- WASHWATER PUMP START pushbutton
- WASHWATER PUMP STOP pushbutton
- WASHWATER PUMP RUNNING indicator
- HYDRAULIC PUMP START pushbutton
- HYDRAULIC PUMP STOP pushbutton
- HYDRAULIC PUMP RUNNING indicator
- BELT DRIVE START pushbutton
- BELT DRIVE STOP pushbutton
- BELT DRIVE RUNNING indicator
- THICKENER DRIVE SPEED controller (0-100%)
- PRESS BELT DRIVE SPEED controller (0-100%)
- BELT CONVEYOR START pushbutton
- BELT CONVEYOR STOP pushbutton
- BELT CONVEYOR RUNNING indicator
- SLUDGE PUMP START pushbutton
- SLUDGE PUMP STOP pushbutton
- SLUDGE PUMP RUNNING indicator
- SLUDGE PUMP SPEED controller (0-100%)
- POLYMER PUMP START pushbutton
- POLYMER PUMP STOP pushbutton
 - POLYMER PUMP RUNNING indicator
- POLYMER PUMP SPEED controller (0-100%)
- THICKENED SLUDGE PUMP START pushbutton
- THICKENED SLUDGE PUMP STOP pushbutton
- THICKENED SLUDGE PUMP RUNNING indicator
- THICKENED SLUDGE PUMP SPEED controller (0-100%)
- BELT MISALIGNED indicator

BELT BROKEN indicator
LOW WASHWATER PRESSURE indicator
LOW HYDRAULIC PRESSURE indicator
GRAVITY SECTION FAIL / BELT BROKEN indicator
HIGH SLUDGE LEVEL indicator
EMERGENCY STOPPED indicator
PRESS DRIVE FAIL indicator
THICKENER DRIVE FAIL indicator
BELT CONVEYOR FAIL indicator
DISCHARGE HOPPER HIGH LEVEL indicator

The control panel shall require the following discrete signal inputs from others. The signals shall be normally open dry contacts and shall close when the equipment is running.

- a) Belt conveyor running
- b) Sludge pump running
- c) Polymer pump running
- d) Thickened sludge pump running

The control panel shall provide the following discrete signals for use by others. The signals shall be dry contacts.

- a) Press running (N.O. close when running)
- b) Press fault (N.O. close on alarm)
- c) Belt conveyor run (N.O. close to run)
- d) Sludge pump run (N.O. close to run)
- e) Polymer pump run (N.O. close to run)
- f) Thickened sludge pump run (N.O. close to run)

The control panel shall require the following analog signals from others.

- a) Sludge pump speed or flow (4-20 mA)
- b) Polymer pump speed or flow (4-20 mA)
- c) Thickened sludge pump speed or flow (4-20 mA)
- d) Discharge hopper level (4-20 mA)

The control panel shall provide the following analog signals.

- a) Sludge pump speed (4-20 mA)
- b) Polymer pump speed (4-20 mA)
- c) Thickened sludge pump speed (4-20 mA)

SEQUENCE OF OPERATION

The press may be operated in the automatic mode by selecting either dewatering (BFP) or thickening (GBT) mode of operation and then placing the HAND/OFF/AUTO selector switch in the AUTO position. The AUTO MODE indicator will illuminate and the operator will press the AUTO START pushbutton. At this time, the washwater pump, washwater valve and hydraulic pump will be energized and a belt tensioning time delay will start.

After the belt tensioning timer times out, the required belt drive(s) will be energized (only the gravity zone belt drive will start if operating in the GBT mode), the belt conveyor will be energized (if the BFP mode is selected) and a belt pre-wet time delay will start. After the pre-wet timer times out, the PRESS READY pilot light will be illuminated and, if the DEWATERING OFF/ON selector switch is in the ON position, the sludge and polymer pumps will be energized. When the level in the hopper rises, the thickened sludge pump will start.

Pressing the AUTO STOP pushbutton will de-energize the sludge and polymer pumps, illuminate the WASHDOWN ON pilot light and start a wash down time delay. A separate conveyor shutdown timer will energize and after timing out, will de-energize the belt conveyor. After the wash down timer times out, the belt drive, hydraulic pump, washwater pump and washwater valve will be de-energized.

The press may be operated in the manual mode by selecting either dewatering (BFP) or thickening (GBT) mode of operation and then placing the HAND/OFF/AUTO selector switch in the HAND position. The HAND MODE indicator will be illuminated. The operator will start the washwater pump by pressing the WASHWATER PUMP START pushbutton; start the hydraulic pump by pressing the HYDRAULIC PUMP START pushbutton. Anytime the washwater pump is running, the washwater valve shall be energized.

The operator should not proceed until the belts have been fully tensioned. No interlock is provided to prevent the operator from starting the belt drive in the manual mode. Pressing the BELT DRIVE START pushbutton will energize the required belt drive(s) and after a pre-wet time delay will illuminate the PRESS READY pilot light. At this time, the operator will start the belt conveyor by pressing the BELT CONVEYOR START pushbutton, start the sludge pump by pressing the SLUDGE PUMP START pushbutton and start the polymer pump by pressing the POLYMER PUMP START pushbutton. After the sludge level rises in the discharge hopper, the operator may start the thickened sludge pump by pressing the THICKENED SLUDGE PUMP START pushbutton.

Pressing the respective STOP pushbutton in the reverse order stated above will stop the system.

FAULTS

When any of the following fault conditions occur, in automatic or manual mode, the appropriate fault indicator will be illuminated, the alarm horn will sound and the belt filter press and associated equipment will be de-energized.

- EMERGENCY STOP
- BELT MISALIGNED
- BELT BROKEN
- LOW WASHWATER PRESSURE
- HYDRAULIC PRESSURE FAULT
- GRAVITY SECTION FAIL / BELT BROKEN
- THICKENER DRIVE FAIL
- PRESS DRIVE FAIL

BELT CONVEYOR FAIL

ENCLOSURES

Control panel enclosures shall be fabricated of type 304 stainless steel and shall be suitable for NEMA 4X service. Enclosures shall be manufactured by Hoffman Manufacturing, Steeline or equal.

WIRING

All power and control wiring shall be 600 volt, type THHN/THWN or MTW insulation stranded copper and shall be sized for the required load, 14 AWG minimum.

CIRCUIT BREAKERS

The circuit breaker for the main disconnect shall be thermal magnetic molded case units. The circuit breaker shall be Square D FAL type or equal.

MOTOR STARTERS

Motor starters shall be full voltage, non-reversing, IEC style across-the-line units. Coils shall be 120 VAC. The starters shall be Allen Bradley style 140M w/100 contactors.

SPEED CONTROLLERS

The speed controllers shall be capable of outputting a 4-20ma DC or 0-10v DC setpoint control signal and accept a 4-20ma DC or 0-10v DC status signal. The controller shall be capable of PID control. The controller shall be Red Lion P48 or equal.

SELECTOR SWITCHES

All selector switches shall be heavy duty, oil tight/watertight, corrosion resistant units rated for NEMA 4X service. Contact blocks shall be rated for 10-ampere continuous service. Selector switches shall be Allen Bradley Type 800H or equal.

PUSHBUTTONS

All pushbuttons shall be heavy duty, oil tight/watertight, corrosion resistant units rated for NEMA 4X service. Contact blocks shall be rated for 10-ampere continuous service. Pushbuttons shall be Allen Bradley Type 800H or equal.

PILOT LIGHTS

Pilot lights shall be heavy duty, oil tight/watertight, corrosion resistant units rated for NEMA 4X service. Units shall be 120 VAC transformer type. Pilot lights shall be Allen Bradley Type 800H or equal.

TERMINAL BLOCKS

Terminal blocks shall be high density, spring cage clamp style, with 600 volt rating. Terminal blocks shall be WAGO, Class 280, Type M, or equal.

PROGRAMMABLE LOGIC CONTROLLER

CITY OF PIKEVILLE 0.366 MGD
WASTEWATER TREATMENT PLANT
CONSTRUCTION DOCUMENT SUBMITTAL

467621-20

The PLC shall be a modular type with discrete and analog capabilities. The CPU shall have 4K minimum RAM for user instructions. The unit shall have battery backed RAM and EEPROM backup. The PLC shall be an Allen Bradley Compact Logix or equal.

VARIABLE FREQUENCY DRIVE (VFD)

The VFDs shall be UL listed and shall be Allen Bradley Powerflex style or approved equal.

2.17 Spare Parts

The following spare parts shall be furnished with the belt filter presses:

1. One set of filter belts for each press supplied.
2. Two complete sets of doctor blades for each press supplied.
3. One of each size and type of roller bearing complete.
4. Two complete sets of rubber seals for each press supplied.

PART 3 MANUFACTURER'S SERVICES

3.01 Start-up and Operator Training

Services of the manufacturer's factory trained representative, who is specifically knowledgeable in the type of equipment specified herein, shall be provided during the equipment installation period. Upon complete installation of equipment by installing contractor, including placement of equipment, setting and leveling the equipment, piping and electrical connections to all the equipment specified herein, the manufacturer's service representative will approve the installation and begin start up and training.

Upon approval of the installation, the services of the manufacturer's factory trained representative shall be provided at the project site for equipment start-up and calibration. During the start-up and calibration phase the manufacturer's representative shall inspect all system components for proper connection and alignment and assist the installation contractor in placing the equipment in a proper operating condition.

Upon satisfactory completion of the start-up and calibration, a representative of the manufacturer shall be provided to instruct Owner's personnel in the proper operation and maintenance of the equipment. The manufacturer's representative who will be providing the instruction shall have prior operation, maintenance and instructing experience acceptable to the Engineer. The contractor shall submit the individual's name and qualifications to the Engineer for approval at least one week prior to the scheduled operating and maintenance instruction sessions. The number of days listed below for services of the manufacturer's factory trained representative shall be provided when requested by the Owner or the Engineer during the contract period.

The manufacturer's representative shall complete all of the above sessions in a total of two trips to the jobsite. The equipment manufacturer will request in writing that all installation prior to arriving at the jobsite be completed by the contractor. If the equipment manufacturer arrives at the jobsite and equipment installation is not complete, the equipment manufacturer shall bill the

contractor at the manufacturer's standard service rates, or as agreed to at the time of the service request.

Period	Number of 8-hour days
Inspection / Start Up and Calibration	4
Operator Training	2

- All times listed are per unit.

Additional services, other than those provided for by warranties or as specified herein, may be charged to the Owner/Contractor at the manufacturer's standard service rates or as agreed to at the time of the service request.

END OF SECTION

SECTION 470020

SUBMERSIBLE SCUM PUMPS

PART 1 - GENERAL

1.01 SCOPE:

Under this heading shall be included the furnishing, testing and adjustment of submersible pumps systems as specified herein and as shown on the Drawings. Submersible pumps include two (2) 5 hp pumps for scum.

1.02 RELATED DOCUMENTS:

- A. Division 3 Concrete.
- B. Division 9 Painting.
- C. Division 26 Electrical.

1.03 SUBMITTALS:

Submittal data shall be provided to show compliance with Section 01002, plans or other specifications that will influence the proper operation of the pump(s).

Standard submittal data for approval must consist of:

- a. Pump Performance Curves.
- b. Pump Outline Drawing.
- c. Station Drawing for Accessories.
- d. Electrical Motor Data.
- e. Control Drawing and Data.
- f. Access Frame Drawing.
- g. Typical Installation Guides.
- h. Technical Manuals.
- i. Parts List.
- j. Printed Warranty.
- k. Manufacturer's Equipment Storage Recommendations.
- l. Manufacturer's Standard Recommended Start-Up Report Form.

Lack of the above requested submittal data is cause for rejection.

1.04 SHOP DRAWINGS:

Shop drawings shall show the principal dimensions of the pump assembly, including the size of suction and discharge and details of discharge connection, guide bars, guide brackets, foundation details, lifting cables, shaft seals, lubrication system, motor and casing, and power cable attachment. Shop drawings will be specifically detailed for this project. Guide bars, guide brackets and all hardware installed inside the wetwell shall be 316 stainless steel.

1.05 QUALITY ASSURANCE:

The pump(s) shall be heavy duty, electric submersible recirculating chopper pumps, centrifugal non-clog units designed for handling raw, unscreened sewage and wastewater and shall be fully guaranteed for this use. The pumps provided shall be capable of operating in an ambient liquid temperature of 104°F. Since the high temperature of 104°F is specified by the National Electrical Manufacturers Association (NEMA) and Factory Mutual (FM), motors with a maximum ambient temperature rating below 104°F shall not be acceptable.

The pump and motor unit shall be suitable for continuous operation at full nameplate load while the motor is completely submerged, partially submerged or totally non-submerged. The use of shower systems, secondary pumps or cooling fans to cool the motor shall not be acceptable.

The pump, mechanical seals and motor units provided under this specification shall be from the same manufacturer in order to achieve standardization of operation, maintenance, spare parts, manufacturer's service and warranty.

All equipment, access hatch, guiderails and appurtenances shall be provided by the pump manufacturer.

1.06 DELIVERY, STORAGE & HANDLING:

Material shall be unloaded in a manner that will avoid damage and shall be stored where it will be protected and will not be hazardous to traffic. The Contractor shall repair any damage caused by the storage. Pumps and accessories shall be handled so as to ensure delivery to the site in sound, undamaged condition. Particular care shall be taken not to injure the pumps, cables and accessories. If the pump, cable or accessories are damaged, the Contractor at his expense shall make the repair in a satisfactory manner. Material shall be examined before installation and no damaged or deteriorated material shall be used in the work.

1.07 SEQUENCING & SCHEDULING:

The Contractor is responsible for the construction of all structures and wetwells. The Contractor is also responsible for the installation of the pumps in the structures and wetwells as shown on the drawings.

1.08 GUARANTEE:

The Contractor shall guarantee the quality of the materials, equipment, and workmanship for a period of 12 months after acceptance. The Contractor at no cost to the Owner shall repair defects discovered during that period. The Performance Bond shall reflect this guarantee.

PART 2 - PRODUCTS

2.01 GENERAL:

Each pump shall be suitable for service in raw, unscreened sewage with 3 inch solids and shall conform to the requirements shown on the Drawings and in the Specifications for flow rate, total dynamic head, horse power, voltage and phase. Pumps shall be manufactured by Vaughan, ABS, or engineer approved equal.

2.02 QUALIFICATIONS OF MANUFACTURERS:

The pump manufacturer shall have a minimum of 10,000 heavy-duty submersible wastewater pumps installed and operating for no less than 5 years in the United States.

2.03 DESIGN REQUIREMENTS:

Scum Pumps:

Furnish and install two (2) submersible non-clog recirculating chopper wastewater pump(s). Each pump shall be equipped with a submersible electric motor connected for operation on 460 volts, 3 phase, 60 hertz, 3 wire service, with 40 feet of submersible cable (SUBCAB) suitable for submersible pump applications. The power cable shall be sized according to N.E.C. and CSA and shall be of sufficient length to reach the junction box without requiring splices. The outer jacket of the cable shall be of chlorinated polyethylene (CPE) and be oil, water, and UV resistant, capable of continuous submerged operation underwater to a depth of 65 feet. Each pump shall be fitted with 30 feet of 316 stainless steel lifting chain. The working load of the lifting system shall be 50% greater than the pump unit weight.

Each pump shall meet the following design requirements in Table 470020 – 1:

TABLE 470020 – 1	
SCUM PUMPS - DESIGN REQUIREMENTS	
Item	Design Conditions
Pump Design Speed (rpm)	1750
Discharge Size (inches)	4
Pump Shut-off Head at Design Speed (feet)	39
Motor Horsepower	5
Design TDH (feet)	23
Capacity at Design TDH (gpm)	150
Pump Efficiency at Design TDH (%)	74%
Static Head (feet)	13

2.04 PUMP DESIGN:

There shall be no need for personnel to enter the wet well to remove or reinstall the pump(s). The discharge base & elbow assembly shall be permanently installed in the wet well and connected to the discharge piping. Provide a non-sparking guide rail system consisting of two galvanized or stainless steel guide rails, cast bronze pump guide bracket, cast ductile iron discharge elbow with mounting feet and ANSI CL 125 flanges, 316 stainless steel upper guide rail mounting bracket, and 316 stainless steel intermediate guide rail stiffener bracket every 10 feet. System design shall prevent spark ignition of explosive gases during pump installation and removal. The sliding guide bracket shall be a separate part of the pumping unit, capable of being attached to standard pump flanges, so that the pump mounting is nonproprietary, and any pump with a standard discharge flange can be mounted on the base assembly. Base or bracket assemblies with proprietary or nonstandard flange dimensions shall not be considered acceptable.

A field replaceable Nitrile (Buna-N) rubber profile gasket or O-ring shall accomplish positive sealing of the pump flange/guide rail bracket to the discharge elbow. Base assemblies which rely solely on metal-to-metal contact between the pump flange and discharge base elbow as a means of sealing are inherently leak prone, and shall not be considered equal. No portion of the pump shall bear directly on the floor of the sump. The guide rail system shall be available in an optional non-sparking version, approved by Factory Mutual for use in NEC Class 1, Division 1, Group C&D hazardous locations.

2.05 RECIRCULATION SYSTEM:

Manual Recirculation Nozzle Assembly: The pump shall be fitted with a recirculation nozzle assembly to permit recirculation of the pit contents prior to discharge. The recirculation nozzle shall be adjustable minimum 180 degrees horizontally and 45 degrees vertically. A valve assembly shall be connected to the pump discharge to adjust pump flow either to the nozzle or the pump discharge flange. Valve shall be cast ductile iron, with CD4MCu stainless steel valve disc and ANSI CL 125 flanged recirculation and discharge flange. The operating levers shall be located above at a mounting plate for easy access.

2.05 PUMP CONSTRUCTION:

- A. Casing: Shall be of volute design, spiraling outward to the ANSI CL 125 flanged centerline discharge. Casing shall be cast ductile iron with all water passages to be smooth, and free of blowholes and imperfections for good flow characteristics. Casing shall include a replaceable Rockwell C60 steel insert cutter to cut against the rotating impeller pump-out vanes for removing fiber and debris.
- B. Impeller: Shall be semi-open type with pump out vanes to reduce seal area pressure. Chopping of materials shall be accomplished by the action of the cupped and sharpened leading edges of the impeller blades moving across the cutter bar at the intake openings, with a set clearance between the impeller and cutter bar of 0.015-0.025" cold. Impeller shall be cast steel heat treated to minimum Rockwell C60 and dynamically balanced. The impeller shall have no axial adjustments and no set screws. Pumps with open type impellers or impellers without modified pump out vanes to shear against the upper cutter shall not be acceptable.
- C. Cutter Bar: Shall be recessed into the pump casing and shall contain at least 2 shear bars extending diametrically across the intake opening to within 0.010-0.030" of the rotating cutter nut tooth, for the purpose of preventing intake opening blockage and wrapping of debris at the shaft area. Cutter bar shall be cast steel heat-treated to minimum Rockwell C60. Chopper pumps utilizing individually mounted shear bars shall not be acceptable.
- D. Cutter Nut: The impeller shall be secured to the shaft using a cutter nut, designed to cut stringy materials and prevent binding using a raised, rotating cutter tooth. The cutter nut shall be cast steel heat treated to minimum Rockwell C60. Due to the solids handling demand in this application, impeller securing devices that lack the ability to cut debris from the pump suction shall not be acceptable.
- E. Upper Cutter: Shall be threaded into the casing or back-plate behind the impeller, designed to cut against the pump-out vanes and the impeller hub, reducing and removing stringy materials from the mechanical seal area. The upper cutter shall have no more than two anvils that are positioned as closely as possible to the center of shaft rotation to minimize cutting torque, the potential for binding, and nuisance motor tripping. The ratio of upper cutter cutting diameter to shaft diameter in the upper cutter area of the pump shall be 3.0 or less. Upper cutter shall be cast steel heat treated to minimum Rockwell C60.
- F. Pump Shafting: Shafting shall be heat treated steel, with a minimum diameter of

1.5 inches in order to minimize deflection during solids chopping. Mounting of the pump impeller directly to the motor shaft shall not be allowed on this project as this results in an unacceptable overhang distance from the impeller to the lowest mechanical seal.

- G. Bearing Housing: Shall be cast ductile iron and machined with piloted bearing fits for concentricity of all components. Piloted motor mount shall securely align motor on top of bearing housing. A pump mechanical seal shall also be provided to isolate the pump bearings and the lower motor seal from the pumped media. Pumps that expose the lower motor seal to the pumpage shall be considered unacceptable.
- H. Thrust Bearings: Shaft thrust in both directions shall be taken up by two angular contact ball bearings, or a single tapered roller bearing, with a minimum L-10 rated life of 100,000 hours. Overhang from the centerline of the lower thrust bearing to the seal faces shall be a maximum of 1.7". The bearings and pump seal shall be oil bath lubricated in the bearing housing by ISO 46 hydraulic oil. Shaft overhang exceeding 1.7 inches from the center of the lowest thrust bearing to the seal faces shall be considered unacceptable.
- I. Pump Mechanical Seal: The mechanical seal is to be manufactured and warranted by the pump manufacturer. Pump manufacturer is to have at least 15 years' experience producing the mechanical seal and a documented history of 10 years of installations in the same application as specified. The mechanical seal shall be located immediately behind the impeller hub to maximize the flushing available from the impeller pump-out vanes. The seal shall be a cartridge-type mechanical seal with Viton O-rings and silicon carbide (or tungsten carbide) faces. This cartridge seal shall be pre-assembled and pre-tested so that no seal settings or adjustments are required from the installer. Any springs used to push the seal faces together must be shielded from the fluid to be pumped. The cartridge shall also include a 17-4PH, heat-treated seal sleeve and a ductile iron seal gland.
- J. Automatic Oil Level Monitor: An oil level switch shall be mounted at the top of the wet well, with a hose feeding down to the side of the bearing housing to monitor oil level and shut off the motor in event of low oil level. A relay shall be included for mounting in the motor control panel.
- K. Shaft Coupling: The submersible motor shall be close coupled directly to the pump shaft using a solid sleeve coupling, which is keyed to both the pump and motor shafts. Slip clutches and shear pins between the shaft and the motor are considered unacceptable.
- L. Stainless Steel Nameplate: Shall be attached to the pump and drive motor giving the manufacturer's model and serial number, rated capacity, head, speed and all pertinent data.

2.06 COOLING SYSTEM:

Each phase of the motor shall contain a normally closed bi-metallic temperature monitor switch imbedded in the motor windings. These thermal switches shall be

connected in series and set to open at 284°F. They shall be connected to the control panel to provide a high stator temperature shutdown signal, and are used in conjunction with external motor overload protection.

2.07 CABLE ENTRY SEAL:

The cable entry system shall consist of a submersible plug assembly which allows the cable to be easily disconnected from the pump for service or replacement. Cable sealing shall be accomplished by a Nitrile or Viton, compression grommet with both cylindrical and conical sealing surfaces, flanked by a stainless steel washer and an integrated strain relief. A brass, 2.0401 (ASTM B455, Grade C38500), compression nut shall be threaded into the cast iron, EN-GJL-250 (ASTM A-48, Class 35B), cable plug housing, compressing the grommet ID to the cable while the grommet OD seals against the bore of the cable entry housing. Cable conductors shall be terminated in copper pin connectors which are separated and retained by a circular pin retainer fabricated from high dielectric strength Polyamid (30% GF). Each pin shall pass through its own hole in the pin retainer, maintaining perfect alignment with the mating pins in the motor body. The corresponding motor body pin assembly shall be manufactured from high dielectric strength Polyamid (30% GF), with copper connector pins. The pin assembly shall be sealed with an O-ring to prevent water entry into the motor, and retained in the motor housing bore via a retaining ring. Attachment of the plug assembly to the motor shall engage the corresponding copper pins, creating a complete circuit between the motor and cable. The plug assembly shall be fastened with stainless steel fasteners, and shall be sealed by an O-ring.

The cable plug and sealed entry system as part of the motor shall be FM and CSA approved for use in NEC Class I, Division I, Groups C & D hazardous locations. The system shall be anti-wicking by design, and shall prevent any water that enters the cable through damage to the jacket from entering the motor. Cable entry designs which utilize potting compounds to provide a water tight seal or those which do not allow the cable to be easily changed in the field shall not be considered equal.

2.08 MOTOR:

The motor shall be housed in a water-tight gray cast iron, ASTM A-48, Class 35B, enclosure, capable of continuous submerged operation underwater to a depth of 65 feet. The motor shall be of the squirrel-cage induction design, NEMA type B. The copper stator windings shall be insulated with moisture resistant, Class H insulation material, rated for 356°F. The stator shall be press fitted into the stator housing. The use of bolts, pins, or other fastening devices requiring penetration of the stator housing is unacceptable. The rotor bars and short circuit rings shall be made of cast aluminum.

The motor shall be designed for continuous duty. The maximum continuous temperature of the pumped liquid shall be 104°F, and intermittently up to 122°F. The motor shall be capable of handling up to 15 evenly spaced starts per hour without overheating. The service factor (as defined by the NEMA MG1 standard) shall be 1.15. The motor shall have a voltage tolerance of +/- 10% from nominal, and a phase-to-phase voltage imbalance tolerance of 1%. The motor shall have a NEMA Class A temperature rise, providing cool operation under all operating conditions. The motor shall be FM approved for use in NEC Class I, Division I, Groups C & D hazardous locations. The surface temperature rating shall be T3C.

The motor shall be capable of operating, completely submerged, partially submerged, or unsubmerged. For submerged (wet-pit) applications, the motor shall be self cooling via the process fluid surrounding the motor. The motor shall have a NEMA Class A temperature rise for submerged service, providing cool operation under all operating conditions.

2.09 BEARINGS:

Each pump shaft shall rotate on high quality, permanently lubricated, greased bearings. The upper bearing shall be a deep grooved ball bearing and the lower bearing shall be a heavy duty, double row, angular contact ball bearing. Bearings shall be of sufficient size and properly spaced to transfer all radial and axial loads to the pump housing and minimize shaft deflection. L-10 bearing life shall be a minimum of 50,000 hours at flows ranging from ½ of BEP flow to 1½ times BEP flow (BEP is best efficiency point). The bearings shall be manufactured by a major internationally known manufacturer of high quality bearings, and shall be stamped with the manufacturer's name and size designation on the race. Generic or unbranded bearings from other than major bearing manufacturers shall not be considered acceptable.

2.10 MECHANICAL SEAL:

Each pump shall be equipped with a tandem mechanical shaft seal system consisting of two totally independent seal assemblies. The seals shall operate in a lubricant reservoir that hydro-dynamically lubricates the lapped seal faces at a constant rate. The lower, primary seal unit, located between the pump and the lubricant chamber, shall contain one stationary industrial duty silicon-carbide seal ring and one rotating industrial duty silicon-carbide seal ring. The stationary ring of the primary seal shall be installed in a seal holding plate of gray cast iron, ASTM A-48, Class 35B. The seal holding plate shall be equipped with swirl disruption ribs to prevent abrasive material from prematurely wearing the seal plate. The upper, secondary seal unit, located between the lubricant chamber and motor housing, shall contain one stationary industrial duty silicon-carbide seal ring, and one rotating industrial duty silicon-carbide seal ring. Each seal interface shall be held in contact by its own spring system. The seals shall not require

routine maintenance or adjustment, and shall not be dependent on the direction of rotation for proper sealing. Each pump shall be provided with a lubricant chamber for the shaft sealing system which shall provide superior heat transfer and maximum seal cooling. The lubricant chamber shall be designed to prevent overfilling, and to provide lubricant expansion capacity. The drain and inspection plug shall have a positive anti-leak seal and shall be easily accessible from the outside of the pump. The seal system shall not rely upon the pumped media for lubrication and shall not be damaged when the pump is run dry. Seal lubricant shall be FDA Approved, nontoxic.

The following seal types shall not be considered equal: Seals of proprietary design or seals manufactured by other than major independent seal manufacturing companies. Seals requiring set screws, pins, or other mechanical locking devices to hold the seal in place, conventional double mechanical seals containing either a common single or double spring acting between the upper and lower seal faces, or any system requiring a pressure differential to seat the seal and ensure sealing.

2.11 PUMP SHAFT:

The pump shaft and motor shaft shall be an integral, one piece unit adequately designed to meet the maximum torque required at any normal start-up condition or operating point in the system. The shaft shall have a full shutoff head design safety factor of 1.7, and the maximum shaft deflection shall not exceed .002 inch at the lower seal during normal pump operation. Each shaft shall be of stainless steel, AISI 420, and shall have a polished finish with accurately machined shoulders to accommodate bearings, seals, and impeller. Carbon steel, chrome plated, or multi-piece welded shafts shall not be considered adequate or equal

2.12 IMPELLER:

The impeller shall be of gray cast iron, ASTM A-48, Class 35B, with the option of upgrading to duplex stainless steel, ASTM A890, CD3MN Grade 4A. The impeller shall be of the semi-open, non-clogging, single-vane design, with a minimum solids passage size of 3 inches. The impeller shall be capable of passing a minimum of 3.0 inch spherical solid. The impeller shall have a slip fit connection onto the motor shaft, driven by a shaft key, and shall be securely fastened to the shaft by a stainless steel screw. A positively engaged, ratcheting washer assembly shall prevent the screw from loosening. The head of the impeller screw shall be effectively recessed within the impeller bore to prevent disruption of the flow stream and loss of hydraulic efficiency. The impeller shall be dynamically balanced to the ISO 10816 standard to provide smooth, vibration-free operation. Impeller designs which do not meet the minimum requirement for 3 inch solids passage size, those that rely on retractable impeller designs to pass 3 inch solids, or those that rely on fins or pins protruding into the suction path to assist in the handling of fibrous material shall not be considered equal.

2.13 WEAR PLATE:

The wear plate shall be of gray cast iron, ASTM A-48, Class 35B, with the option of upgrading to duplex stainless steel, ASTM A890, CD3MN Grade 4A. The wear plate shall be designed with an inlet incorporating strategically placed cutting grooves as well as an outward spiral V-shaped groove on the side facing the impeller. The dual groove system shall be used to shred and force stringy solids outward from the impeller and through the pump discharge. The wear plate shall be mounted to the volute with three stainless steel securing screws and three stainless steel adjusting screws to permit close tolerance adjustment between the wear plate and impeller for maximum pump efficiency. The wear plate shall be factory mounted to the volute in a fixed position with metal-to-metal contact on machined surfaces to insure optimal clearance and efficiency at startup. Future adjustments shall be easily accomplished by removing three securing screws and rotating the plate 45 degrees to the adjustment position. Adjustment to allow for wear and restore peak pumping performance shall then be accomplished using standard tools, and without requiring disassembly of the pump. The use of fixed or non-adjustable wear plates or rings, systems that require disassembly of the pump, or shimming of the impeller to facilitate adjustment, shall not be considered equal. The suction flange shall be integrated into the wear plate and its bolt holes shall be drilled and tapped to accept standard 6 inch ANSI class 125/150 flanged fittings.

2.14 VOLUTE:

The pump volute shall be a single-piece, gray cast iron, ASTM A-48, Class 35B, non-concentric design with centerline discharge. Passages shall be smooth and large enough to pass any solids which may enter through the impeller. The discharge size shall be 4 inches. The discharge flange design shall permit attachment to standard ANSI and DIN flanges/appurtenances. The discharge flange shall be radially slotted to accept both 4 inch ANSI class 125/150 and metric DN150 flanged fittings. Proprietary or nonstandard flange dimensions shall not be considered acceptable. The minimum working pressure of the volute and pump assembly shall be 232 psi.

2.15 PROTECTION:

The primary mechanical seal shall be protected from interference by particles in the wastewater, including fibrous materials, by an active Seal Protection System integrated into the impeller. The back side of the impeller shall be equipped with a sinusoidal cutting ring, forming a close clearance cutting system with the lower submersible motor housing or seal plate. This sinusoidal cutting ring shall spin with the pump impeller providing a minimum of 75 shearing actions per pump revolution. Large particles or fibrous material which attempt to lodge behind the

impeller or wrap around the mechanical seal, shall be effectively sheared by the active cutting system into particles small enough to prevent interference with the mechanical seal.

The Seal Protection System shall operate whenever the pump operates, and shall not require adjustment or maintenance in order to function. Submersible pump designs which do not incorporate an active cutting system to protect the primary mechanical seal shall not be considered acceptable for wastewater service.

2.16 SEAL FAILURE EARLY WARNING SYSTEM:

The integrity of the mechanical seal system shall be continuously monitored during pump operation and standby time. An electrical probe shall be provided in a sensing chamber positioned between the primary and secondary mechanical seals for detecting the presence of water contamination within the chamber. The sensing chamber shall be filled with environmentally safe nontoxic oil. A solid-state relay mounted in the pump control panel or in a separate enclosure shall send a low voltage, low amperage signal to the probe, continuously monitoring the conductivity of the liquid in the sensing chamber. If sufficient water enters the sensing chamber through the primary mechanical seal, the probe shall sense the increase in conductivity and signal the solid state relay in the control panel. The relay shall then energize a warning light on the control panel, or optionally, cause the pump shut down. This system shall provide an early warning of mechanical seal leakage, thereby preventing damage to the submersible motor, and allowing scheduled, rather than emergency, maintenance. Systems utilizing float switches or any other monitoring devices located in the stator housing rather than in a sensing chamber between the mechanical seals are not considered to be early warning systems, and shall not be considered equal.

2.17 ACCESS FRAME AND COVER:

Aluminum access frames complete with hinged and hasp-equipped aluminum, designed for 300 lb per square foot live load covers, upper guide holder and cable holder shall be furnished. Each door shall have a safety handle to maintain the door in the open position. Doors shall be of checkered aluminum plate and the size shown on the drawings. Cover guide bar holders shall be integral with the discharge connection. Access frame shall be provided with safety hatch as manufactured by Syracuse Castings or approved equal. Each safety hatch shall be designed to support the submersible pump as installed.

2.18 LIQUID LEVEL SENSOR AND PUMP CONTROLLER:

A liquid level transducer sensor and backup high water and low water float switches are required for the influent and drain lift station wetwell. Liquid level sensor and float switch models and requirements are specified in Electrical

PART 3 - EXECUTION

3.01 TESTING:

Testing performed upon each pump shall include the following inspections:

- a. Impeller, motor rating and electrical connections shall be checked for compliance with this specification.
- b. Prior to submergence, each pump shall be run dry to establish correct rotation.
- c. Each pump shall be run submerged in water.
- d. Motor and cable insulation shall be tested for moisture content or insulation defects.

Upon request, a written quality assurance record confirming the above testing/inspections shall be supplied with each pump at the time of shipment.

Each pump (when specified) shall be tested in accordance with the latest test code of the Hydraulic Institute (HI) at the manufacturer to determine head vs. capacity and kilowatt draw required. Witness tests shall be available at the factory upon request.

The pump(s) shall be rejected if the above requirements are not satisfied.

3.02 START-UP SERVICE:

The equipment manufacturer shall furnish the services of a qualified factory trained field service engineer for 8-hour working day(s) at the site to inspect the installation and instruct the owner's personnel on the operation and maintenance of the pumping units. After the pumps have been completely installed and wired, the contractor shall have the manufacturer do the following:

- a. Megger stator and power cables.
- b. Check seal lubrication.
- c. Check for proper rotation.
- d. Check power supply voltage.
- e. Measure motor operating load and no load current.
- f. Check level control operation and sequence.

During this initial inspection, the manufacturer's service representative shall review recommended operation and maintenance procedures with the owner's personnel.

3.03 FACTORY SERVICE:

Factory-Approved service facilities with qualified factory trained mechanics shall be available for prompt emergency and routine service.

The pump manufacturer shall warrant the pumps in writing against defects in workmanship and material for a period of five (5) years or 10,000 hours of normal use, operation and service. The warranty shall be in printed form and apply to all similar units. Warranty shall cover both parts and labor on a pro-rated basis after the first year. The first year warranty shall cover 100 percent labor and materials cost.

3.04 OPERATION AND MAINTENANCE MANUALS

The manufacturer shall furnish Operation and Maintenance Instructions as specified in Section 01002.

END OF SECTION

SECTION 470030

DRY- INSTALLED RETURN ACTIVATED SLUDGE (RAS) PUMPS

PART 1 - GENERAL

1.01 SCOPE:

Under this heading shall be included the furnishing, testing and adjustment of dry-installed pump systems as specified herein and as shown on the Drawings. Dry-installed pumps include four (4) 5 hp VFD pumps for return activated sludge.

1.02 RELATED DOCUMENTS:

- A. Division 3 Concrete.
- B. Division 9 Finishes.
- C. Division 26 Electrical.

1.03 SUBMITTALS:

Submittal data shall be provided to show compliance with Section 01002, plans or other specifications that will influence the proper operation of the pump(s).

Standard submittal data for approval must consist of:

- a. Pump Performance Curves.
- b. Pump Outline Drawing.
- c. Station Drawing for Accessories.
- d. Electrical Motor Data.
- e. Control Drawing and Data.
- f. Access Frame Drawing.
- g. Typical Installation Guides.
- h. Technical Manuals.
- i. Parts List.
- j. Printed Warranty.
- k. Manufacturer's Equipment Storage Recommendations.
- l. Manufacturer's Standard Recommended Start-Up Report Form.

Lack of the above requested submittal data is cause for rejection.

1.04 SHOP DRAWINGS:

Shop drawings shall show the principal dimensions of the pump assembly, including the size of suction and discharge and details of discharge connection, guide brackets, foundation details, shaft seals, lubrication system, motor and casing, and power cable attachment. Shop drawings will be specifically detailed for this project. Guide brackets and all hardware installed inside the wetwell shall be 316 stainless steel.

1.05 QUALITY ASSURANCE:

The pump(s) shall be heavy duty, electric dry-installed, centrifugal non-clog units designed for handling raw, unscreened sewage and wastewater and shall be fully guaranteed for this use. The pumps provided shall be capable of operating in an ambient liquid temperature of 104°F. Since the high temperature of 104°F is specified by the National Electrical Manufacturers Association (NEMA) and Factory Mutual (FM), motors with a maximum ambient temperature rating below 104°F shall not be acceptable.

The pump and motor unit shall be suitable for continuous operation at full nameplate load while the motor is completely submerged, partially submerged or totally non-submerged. The use of shower systems, secondary pumps or cooling fans to cool the motor shall not be acceptable.

The pump, mechanical seals and motor units provided under this specification shall be from the same manufacturer in order to achieve standardization of operation, maintenance, spare parts, manufacturer's service and warranty.

All equipment and appurtenances shall be provided by the pump manufacturer.

1.06 DELIVERY, STORAGE & HANDLING:

Material shall be unloaded in a manner that will avoid damage and shall be stored where it will be protected and will not be hazardous to traffic. The Contractor shall repair any damage caused by the storage. Pumps and accessories shall be handled so as to ensure delivery to the site in sound, undamaged condition. Particular care shall be taken not to injure the pumps, cables and accessories. If the pump, cable or accessories are damaged, the Contractor at his expense shall make the repair in a satisfactory manner. Material shall be examined before installation and no damaged or deteriorated material shall be used in the work.

1.07 SEQUENCING & SCHEDULING:

The Contractor is responsible for the construction of all structures and wetwells. The Contractor is also responsible for the installation of the pumps in the structures and wetwells as shown on the drawings.

1.08 GUARANTEE:

The Contractor shall guarantee the quality of the materials, equipment, and workmanship for a period of 12 months after acceptance. The Contractor at no cost to the Owner shall repair defects discovered during that period. The Performance Bond shall reflect this guarantee.

PART 2 - PRODUCTS

2.01 GENERAL:

Each pump shall be suitable for service in raw, unscreened sewage with 3 inch solids and shall conform to the requirements shown on the Drawings and in the Specifications for flow rate, total dynamic head, horse power, voltage and phase. Pumps shall be manufactured by Vaughan, ABS, or engineer approved equal.

2.02 QUALIFICATIONS OF MANUFACTURERS:

The pump manufacturer shall have a minimum of 10,000 heavy-duty submersible wastewater pumps installed and operating for no less than 5 years in the United States.

2.03 DESIGN REQUIREMENTS:

Return Activated Sludge Pumps:

Furnish and install four (4) dry-installed non-clog wastewater pump(s). Each pump shall be equipped with an electric motor connected for operation on 230/460 volts, 3 phase, 60 hertz, 3 wire service, with 40 feet of submersible cable (SUBCAB) suitable for submersible pump applications. Pumps will operate on variable frequency drives. The power cable shall be sized according to N.E.C. and CSA and shall be of sufficient length to reach the junction box without requiring splices. The outer jacket of the cable shall be of chlorinated polyethylene (CPE) and be oil, water, and UV resistant, capable of continuous submerged operation underwater to a depth of 65 feet.

Each pump shall meet the following design requirements in Table 470015 – 1:

TABLE 470015 – 1	
RAS PUMPS - DESIGN REQUIREMENTS	
Item	Design Conditions
Pump Design Speed (rpm)	1170
Discharge Size (inches)	4
Pump Shut-off Head at Design Speed (feet)	36
Motor Horsepower	5
Design TDH (feet)	7
One Pump Capacity at Design TDH (gpm)	318

TABLE 470015-1 (Cont.)	
RAS PUMPS – DESIGN REQUIREMENTS	
Pump Efficiency at Design TDH (%)	70%
Static Head (feet)	5

2.04 PUMP CONSTRUCTION:

Major pump components shall be of cast ductile iron, ASTM A-48, Class 35B, with smooth surfaces devoid of porosity or other irregularities. All exposed nuts or bolts shall be AISI type 316 stainless steel construction. All metal surfaces coming into contact with the pumpage, other than stainless steel, shall be protected by a factory applied spray coating of zinc phosphate primer with a two-part epoxy paint finish on the exterior of the pump.

Sealing design for the pump/motor assembly shall incorporate machined surfaces fitted with Nitrile rubber O-rings or Viton. Sealing will be the result of controlled compression of rubber O-rings in two planes of the sealing interface. Housing interfaces shall meet with metal-to-metal contact between machined surfaces, and sealing shall be accomplished without requiring a specific torque on the securing fasteners. Rectangular cross sectioned gaskets requiring specific torque limits to achieve compression shall not be considered equal. No secondary sealing compounds shall be required or used.

2.05 COOLING SYSTEM:

The factory installed closed-loop cooling system shall be of gray cast iron, ASTM A-48, Class 35B, adequately designed to allow the motor to run continuously under full load while in an unsubmerged (dry-pit) or minimally submerged condition without the need for de-rating or reduced duty cycle. A cooling jacket shall surround the stator housing, and an environmentally safe nontoxic propylene glycol solution shall be circulated through the jacket by an axial flow circulating impeller attached to the main motor shaft. The coolant shall be pumped through an integrated heat exchanger in the base of the motor whenever the motor is running, allowing excess heat to be transferred to the process liquid. Cooling systems that circulate the pumped medium through the cooling jacket, or those that use a toxic cooling liquid shall not be acceptable. The use of external heat exchangers, fans, or the supply of supplemental cooling liquid shall not be required.

Each phase of the motor shall contain a normally closed bi-metallic temperature monitor switch imbedded in the motor windings. These thermal switches shall be connected in series and set to open at 284°F. They shall be connected to the control panel to provide a high stator temperature shutdown signal and are used in conjunction with external motor overload protection.

2.06 CABLE ENTRY SEAL:

The cable entry design shall not require a specific torque to insure a watertight seal. The cable entry shall consist of cylindrical elastomer grommets, flanked by stainless steel washers. A cable cap incorporating a strain relief and bend radius limiter shall mount to the cable entry boss, compressing the grommet ID to the cable while the grommet OD seals against the bore of the cable entry. The junction chamber shall be isolated and sealed from the motor by means of sealing glands. Electrical connections between the power cables and motor leads shall be made via a compression or post type terminal board, allowing for easy disconnection and maintenance.

2.07 MOTOR:

The motor shall be housed in a water-tight gray cast iron, ASTM A-48, Class 35B, enclosure, capable of continuous submerged operation underwater to a depth of 65 feet and shall have an IP68 protection rating. The motor shall be of the squirrel-cage induction design, NEMA type B. The copper stator windings shall be insulated with moisture resistant, Class H insulation material, rated for 356°F. The stator shall be press fitted into the stator housing. The use of bolts, pins, or other fastening devices requiring penetration of the stator housing is unacceptable. The rotor bars and short circuit rings shall be made of cast aluminum.

The motor shall be designed for severe duty. The maximum continuous temperature of the pumped liquid shall be 104°F, and intermittently up to 122°F. The motor shall be capable of handling up to 15 evenly spaced starts per hour without overheating. The service factor (as defined by the NEMA MG1 standard) shall be 1.15. The motor shall have a voltage tolerance of +/- 10% from nominal, and a phase-to-phase voltage imbalance tolerance of 1%. The motor shall have a NEMA Class A temperature rise, providing cool operation under all operating conditions. The motor shall be FM approved for use in NEC Class I, Division I, Groups C & D hazardous locations. The surface temperature rating shall be T3C. The motor shall meet the requirements of NEMA MG1 Part 30 and 31 for operation on PWM type Variable Frequency Drives.

2.08 BEARINGS:

Each pump shaft shall rotate on high quality, permanently lubricated, greased bearings. Bearings shall be oil-bath lubricated with ISO 46 hydraulic oil. Shaft thrust in both directions shall be taken up by two angular contact ball bearings, or a single tapered roller bearing, mounted in an adjustable position thrust bearing cartridge to permit upper cutter to impeller adjustment. Two adjacently mounted deep groove ball bearings or a cylindrical roller bearing shall also be provided for radial loads. L-10 bearing life shall be a minimum of 100,000 hours at flows ranging from ½ of BEP flow to 1½ times BEP flow (BEP is best efficiency point). The bearings shall be manufactured by a major internationally known manufacturer

of high quality bearings, and shall be stamped with the manufacturer's name and size designation on the race. Generic or unbranded bearings from other than major bearing manufacturers shall not be considered acceptable.

2.10 MECHANICAL SEAL:

Each pump shall be equipped with a tandem mechanical shaft seal system consisting of two totally independent seal assemblies. The seals shall operate in a lubricant reservoir that hydro-dynamically lubricates the lapped seal faces at a constant rate. The lower, primary seal unit, located between the pump and the lubricant chamber, shall contain a cartridge type mechanical seal with Viton O-rings and silicon carbide faces. The cartridge shall also include a 17-4PH, heat treated seal sleeve and stainless steel housing. The stationary ring of the primary seal shall be installed in a seal holding plate of gray cast iron, EN-GJL-250 (ASTM A-48, Class 35B). The seal holding plate shall be equipped with swirl disruption ribs to prevent abrasive material from prematurely wearing the seal plate. The upper, secondary seal unit, located between the lubricant chamber and motor housing, shall contain one stationary industrial duty silicon-carbide seal ring, and one rotating industrial duty silicon-carbide seal ring. Each seal interface shall be held in contact by its own spring system. The seals shall not require routine maintenance or adjustment, and shall not be dependent on the direction of rotation for proper sealing. Each pump shall be provided with a lubricant chamber for the shaft sealing system which shall provide superior heat transfer and maximum seal cooling. The lubricant chamber shall be designed to prevent overfilling, and to provide lubricant expansion capacity. The drain and inspection plug shall have a positive anti-leak seal and shall be easily accessible from the outside of the pump. The seal system shall not rely upon the pumped media for lubrication and shall not be damaged when the pump is run dry. Lubricant in the chamber shall be environmentally safe nontoxic material.

The following seal types shall not be considered equal: Seals of proprietary design or seals manufactured by other than major independent seal manufacturing companies. Seals requiring set screws, pins, or other mechanical locking devices to hold the seal in place, conventional double mechanical seals containing either a common single or double spring acting between the upper and lower seal faces, or any system requiring a pressure differential to seat the seal and ensure sealing.

2.11 PUMP SHAFT:

The pump shaft and motor shaft shall be an integral, one piece unit adequately designed to meet the maximum torque required at any normal start-up condition or operating point in the system. The shaft shall be heat treated alloy steel, and have a full shutoff head design safety factor of 1.7, and the maximum shaft deflection shall not exceed .05 mm (.002 inch) at the lower seal during normal pump operation. Each shaft shall be of stainless steel, 1.4021 (AISI 420), and shall have a polished finish with accurately machined shoulders to accommodate bearings,

seals, and impeller. Carbon steel, chrome plated, or multi-piece welded shafts shall not be considered adequate or equal.

2.12 IMPELLER:

The impeller shall be heat treated cast alloy steel, ASTM A-48, Class 35B, with the option of upgrading to duplex stainless steel, ASTM A890, CD3MN Grade 4A. The impeller shall be of the semi-open, non-clogging, single-vane design, with a minimum solids passage size of 3 inches. The impeller shall be capable of passing a minimum of 3.0 inch spherical solid. The impeller shall have a slip fit connection onto the motor shaft, driven by a shaft key, and shall be securely fastened to the shaft by a stainless steel screw. A positively engaged, ratcheting washer assembly shall prevent the screw from loosening. The head of the impeller screw shall be effectively recessed within the impeller bore to prevent disruption of the flow stream and loss of hydraulic efficiency. The impeller shall be dynamically balanced to the ISO 10816 standard to provide smooth, vibration-free operation. Impeller designs which do not meet the minimum requirement for 3 inch solids passage size, those that rely on retractable impeller designs to pass 3 inch solids, or those that rely on fins or pins protruding into the suction path to assist in the handling of fibrous material shall not be considered equal.

2.13 WEAR PLATE:

The wear plate shall be of gray cast iron, ASTM A-48, Class 35B, with the option of upgrading to duplex stainless steel, ASTM A890, CD3MN Grade 4A. The wear plate shall be designed with an inlet incorporating strategically placed cutting grooves as well as an outward spiral V-shaped groove on the side facing the impeller. The dual groove system shall be used to shred and force stringy solids outward from the impeller and through the pump discharge. The wear plate shall be mounted to the volute with three stainless steel securing screws and three stainless steel adjusting screws to permit close tolerance adjustment between the wear plate and impeller for maximum pump efficiency. The wear plate shall be factory mounted to the volute in a fixed position with metal-to-metal contact on machined surfaces to insure optimal clearance and efficiency at startup. Future adjustments shall be easily accomplished by removing three securing screws and rotating the plate 45 degrees to the adjustment position. Adjustment to allow for wear and restore peak pumping performance shall then be accomplished using standard tools, and without requiring disassembly of the pump. The use of fixed or non-adjustable wear plates or rings, systems that require disassembly of the pump, or shimming of the impeller to facilitate adjustment, shall not be considered equal. The suction flange shall be integrated into the wear plate and its bolt holes shall be drilled and tapped to accept standard 6 inch ANSI class 125/150 flanged fittings.

2.14 VOLUTE:

The pump volute shall be a single-piece, cast ductile iron, ASTM A-48, Class 35B, non-concentric design with centerline discharge. Passages shall be smooth and

large enough to pass any solids which may enter through the impeller. The discharge size shall be 8 inches. The discharge flange design shall permit attachment to standard ANSI and DIN flanges/appurtenances. The discharge flange shall be radially slotted to accept both 8 inch ANSI class 125/150 and metric DN200 flanged fittings. Proprietary or nonstandard flange dimensions shall not be considered acceptable. The minimum working pressure of the volute and pump assembly shall be 145 psi.

2.15 PROTECTION:

The primary mechanical seal shall be protected from interference by particles in the wastewater, including fibrous materials, by an active Seal Protection System integrated into the impeller. The back side of the impeller shall be equipped with a sinusoidal cutting ring, forming a close clearance cutting system with the lower submersible motor housing or seal plate. This sinusoidal cutting ring shall spin with the pump impeller providing a minimum of 75 shearing actions per pump revolution. Large particles or fibrous material which attempt to lodge behind the impeller or wrap around the mechanical seal, shall be effectively sheared by the active cutting system into particles small enough to prevent interference with the mechanical seal.

The Seal Protection System shall operate whenever the pump operates, and shall not require adjustment or maintenance in order to function. Submersible pump designs which do not incorporate an active cutting system to protect the primary mechanical seal shall not be considered acceptable for wastewater service.

2.16 SEAL FAILURE EARLY WARNING SYSTEM:

The integrity of the mechanical seal system shall be continuously monitored during pump operation and standby time. An electrical probe shall be provided in a sensing chamber positioned between the primary and secondary mechanical seals for detecting the presence of water contamination within the chamber. The sensing chamber shall be filled with environmentally safe nontoxic oil. A solid-state relay mounted in the pump control panel or in a separate enclosure shall send a low voltage, low amperage signal to the probe, continuously monitoring the conductivity of the liquid in the sensing chamber. If sufficient water enters the sensing chamber through the primary mechanical seal, the probe shall sense the increase in conductivity and signal the solid state relay in the control panel. The relay shall then energize a warning light on the control panel, or optionally, cause the pump shut down. This system shall provide an early warning of mechanical seal leakage, thereby preventing damage to the submersible motor, and allowing scheduled, rather than emergency, maintenance. Systems utilizing float switches or any other monitoring devices located in the stator housing rather than in a sensing chamber between the mechanical seals are not considered to be early warning systems, and shall not be considered equal.

PART 3 - EXECUTION

3.01 TESTING:

Testing performed upon each pump shall include the following inspections:

- a. Impeller, motor rating and electrical connections shall be checked for compliance with this specification.
- b. Prior to submergence, each pump shall be run dry to establish correct rotation.
- c. Each pump shall be run submerged in water.
- d. Motor and cable insulation shall be tested for moisture content or insulation defects.

Upon request, a written quality assurance record confirming the above testing/inspections shall be supplied with each pump at the time of shipment.

Each pump (when specified) shall be tested in accordance with the latest test code of the Hydraulic Institute (HI) at the manufacturer to determine head vs. capacity and kilowatt draw required. Witness tests shall be available at the factory upon request.

The pump(s) shall be rejected if the above requirements are not satisfied.

3.02 START-UP SERVICE:

The equipment manufacturer shall furnish the services of a qualified factory trained field service engineer for 8-hour working day(s) at the site to inspect the installation and instruct the owner's personnel on the operation and maintenance of the pumping units. After the pumps have been completely installed and wired, the contractor shall have the manufacturer do the following:

- a. Megger stator and power cables.
- b. Check seal lubrication.
- c. Check for proper rotation.
- d. Check power supply voltage.
- e. Measure motor operating load and no load current.
- f. Check level control operation and sequence.

During this initial inspection, the manufacturer's service representative shall review recommended operation and maintenance procedures with the owner's personnel.

3.03 FACTORY SERVICE:

Factory-Approved service facilities with qualified factory trained mechanics shall be available for prompt emergency and routine service.

The pump manufacturer shall warrant the pumps in writing against defects in

workmanship and material for a period of five (5) years or 10,000 hours of normal use, operation and service. The warranty shall be in printed form and apply to all similar units. Warranty shall cover both parts and labor on a pro-rated basis after the first year. The first year warranty shall cover 100 percent labor and materials cost.

3.04 OPERATION AND MAINTENANCE MANUALS

The manufacturer shall furnish Operation and Maintenance Instructions as specified in Section 01002.

END OF SECTION

Appendix A

Geotechnical Report

GEOTECHNICAL ENGINEERING STUDY

**0.366 MGD WASTEWATER
TREATMENT PLANT
Pikeville, Tennessee**

AG & E FILE NUMBER: 2022-070

Prepared By
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Prepared for
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April 11, 2023



**American
Geotechnical and
Environmental, Inc.**

April 11, 2023

Mr. Chris Burke
Hussey Gay Bell
329 Commercial Drive
Savannah, Georgia 31406

RE: Geotechnical Engineering Study
0.366 MGD Wastewater Treatment Plant
Pikeville, Tennessee
AG & E File Number: 2022-070

Dear Mr. Burke:

In compliance with your recent request, we have completed a geotechnical engineering study for the above referenced project. It is our pleasure to transmit our report of the results of this study.

This report represents the results of our findings, an engineering interpretation of these findings with respect to the available project characteristics, and recommendations to aid design and construction of foundations, floor slabs, and other earth related phases of the project.

If you should have any questions concerning this or any other matter, please feel free to contact us at your convenience. It has been a pleasure working with you on this project.

Respectfully Submitted,

AMERICAN GEOTECHNICAL & ENVIRONMENTAL, INC.



Robert T. Stickney, P.E.
President

Enclosure

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GEOTECHNICAL ENGINEERING STUDY
0.366 MGD WASTEWATER TREATMENT PLANT
Pikeville, Tennessee

AG & E FILE NUMBER: 2022-070

1.0 INTRODUCTION

This report presents the results of a geotechnical engineering study for the proposed 0.366 MGD Wastewater Treatment Plant to be built at 2468 Main Street in Pikeville Tennessee. This study was authorized by the design engineer, Hussey Gay Bell, in response to our written proposal dated December 15, 2022.

The scope of geotechnical services provided for this project includes the following:

- Performing a field study of the subsurface soil by the drilling of twenty-one (21) exploratory test borings and,
- The review of available geologic and soil survey maps of the general region, and
- Performing appropriate laboratory tests of selected samples obtained from this site.

The purpose of this study was to determine the types of subsoils present at the proposed site and to evaluate their suitability for support of the proposed building foundations. Included with these services are comments and recommendations relative to the design and construction of the building foundations, floor slabs and pavements for this project.

2.0 SITE AND PROJECT CHARACTERISTICS

The proposed project is planned for construction on the south side of the street as shown in Figure 1. The property has an irregularly shaped property with a north to south axis and covers an area of about 10 acres. The Sequatchie River has a sharp bend along the east side of the property and the southern three quarters of the west side of the property.

The proposed construction area has a moderate slope the south with the western side of the property having a steep slope down to the river. The total relief across the proposed construction area is about 35 feet. The northern side of the property adjacent to Main Street was previously occupied by two structures that have been removed. A third structure currently exists at the location shown in Figure 1. This structure is a single story mobile home. The remainder of the property was previously used as crop land.

Preliminary design plans indicate the proposed project will include the construction of a new wastewater treatment plant. The various structures and proposed floor elevations are summarized below;

Lab/Office Building	846
Headworks structure	827
Aeration Basins	820
Chlorine Contact Basins	820
Clarifiers	811
Aerobic Digester	818
Solids Handling Facility	822

Expected loadings are less than 5 kips per linear foot for continuous wall footings, 1,500 pounds per square foot for slabs, and 150 kips for column footings

3.0 GENERAL SUBSURFACE CONDITIONS

Using standard rotary drill equipment, AG & E drilled twenty one (21) exploratory test borings for this study. These test borings were performed within the proposed building areas as shown on Figure 1. After completion of our field study, the soil samples were returned to our soil mechanics laboratory for analysis and testing.

The elevations noted on the Logs of Test Boring and the Subsurface Fence Diagrams in the Appendix, are interpolated from the topographic survey provided by the client. The subsurface soil profile and groundwater conditions are described in detail on the boring logs in the Appendix to this report, but in general terms consist of the following.

3.1 Subsurface Profile

Past farming practices have resulted in a surface layer of topsoil that is not well defined across most of the property. Where the topsoil can be readily identified, it was measured to be 0.5 to 0.7 feet thick. We recommend assuming the organic layer of soil at the ground surface averages 0.7 feet thick.

The test borings encountered alluvial soil deposits that extend to auger refusal depths that range from 23 to 37 feet deep. Alluvial soils, by definition, have been transported by running water and have settled out when the speed of water flow was no longer sufficient to carry them.

The typical subsurface profile includes a surface layer of reddish brown silty clay that contains trace to some amounts of fine grained sand to depths of 5.5 to 17.0 feet. These upper soils exhibit a moist to very moist condition with a soft to medium stiff consistency as measured by the Standard Penetration Test, N-Values. The N-Values range from 3 to 11 blows per foot.

A 3 to 5 feet thick layer of yellowish red fine grained silty sand was then found at several test borings in the southern portion of the plant. These soils are moist to very moist with a very loose to medium dense relative density with N-Values ranging from 3 to 12 blows per foot.

We then found brown, yellowish brown and yellowish red cherty silty clays that extend beyond the planned exploration depths at most of the test boring locations. Borings No. 6, 12, 13, 14, and 17 were terminated at auger refusal depths of 23.0 to 37.0 feet. The cherty soils also exhibit a moist to very moist condition with a stiff grading to very soft consistency.

The test borings referenced above that encountered auger refusal appeared to be upon the apparent bedrock surface. Auger refusal is defined as the depth below the ground surface at which a test boring can no longer be advanced with the soil drilling technique being used. Rock coring procedures are generally required to determine the character and continuity of the auger refusal material and these factors must be considered when evaluating the depth to auger refusal in those test borings that are not cored.

The auger refusal materials were not cored due to their location being below that which would significantly affect the foundation design. The subject site is located within the Sequatchie Valley in the Cumberland Plateau Physiographic Province. The Sequatchie Valley is a relatively long and narrow valley that was probably formed by erosion of a compression anticline. The valley is bounded on either side by escarpments of the Cumberland Plateau.

The geologic mapping for the Pikeville Quadrant identifies the underlying bedrock as the Lower map unit of the Upper Knox Group. The bedrock is described as a medium gray to medium dark gray limestone that is very fine grained to medium grained and medium to very thick bedded. The limestone is interbedded with dolomite that contains lenses of chert. The bedrock weathers to a highly chert soil.

3.2 Groundwater Conditions

Observations concerning groundwater were made during and at completion of the test boring operations. Groundwater was noted as summarized in Table No. 1.

Table No. 1

GROUNDWATER DEPTHS

Boring No.	Approx. Surface Elevation	Depth of Water At Completion	Elevation
B- 5	835.0	28.0	807.0
B- 6	833.0	28.0	805.0
B- 7	830.0	18.0	812.0
B- 8	829.0	22.0	807.0
B- 9	832.0	26.0	806.0
B- 10	825.0	17.0	808.0
B- 11	826.0	16.0	810.0
B- 12	826.5	14.0	812.5
B- 13	824.0	16.0	808.0
B- 14	823.0	16.0	807.0
B- 15	818.5	11.0	807.5
B- 16	819.5	12.0	807.5
B- 17	822.0	13.0	809.0

The topographic survey indicates the water level in the Sequatchie River is at about Elevation 809 to 810. The groundwater appears to be associated with the water level in the river but it can also be heavily influenced by water infiltration on lands that are upgradient to this property. The sandy and cherty soils found in the soil profile have a relatively high permeability that can only be quantified by a slug test or a pump test. The scope of this study did not include the construction of monitoring wells for long term groundwater measurements and/or pump tests.

4.0 CONCLUSIONS AND RECOMMENDATIONS

Based upon our analysis of the soil conditions, the preliminary design details, and the design assumptions previously outlined, the following conclusions and recommendations were developed. If the project characteristics are changed from those assumed herein, our recommendations should be reviewed to see if any modifications are needed.

4.1 Seismic Recommendations

Based upon Table 20.3-1 Site Classification in Chapter 20 of ASCE 7, this site is classified as Site Class E.

The spectral response acceleration parameters from the ASCE 7 Hazard Tool are shown on Table 2 below.

**Table No. 2
Seismic Design Information**

Spectral Response Acceleration, Site Class "E"	S _s	S ₁	S _{DS}	S _{D1}
Value	0.373	0.115	0.511	0.322

Should a better Site Class designation be desired, a Seismic Site Specific Study is recommended. The depth of overburden soil will also require the performance of a Shear Wave Velocity Test that will provide site specific shear wave parameters for the structural engineer.

4.2 Earth Pressure Coefficients

We recommend the structure use the following coefficients for lateral earth pressure for the different soil strata;

**Table No. 3
Lateral Earth Pressures**

<u>Stratum</u>	<u>Active Coefficient</u>	<u>Passive Coefficient</u>	<u>At-Rest Coefficient</u>	<u>Unit Weight, pcf</u>	<u>Buoyant Unit Wt., pcf</u>	<u>Angle of Internal Friction</u>	<u>Cohesion</u>
Brown and dark brown silty clays, 0 to 7 feet	0.53	1.89	0.69	105		18	0
Reddish brown and yellowish red cherty silty clay, 7 to 20 feet	0.49	2.04	0.66	115		20	0
Reddish brown and yellowish red cherty silty clay, > 20 feet	0.61	1.64	0.76	110	65	14	0

4.3 Lab/Office Building Foundation Recommendations

The Lab/Office Building will be a two story structure with the proposed Finish Floor Elevation at Elevation 846.0. The existing ground surface ranges between Elevation 845 to 854. This will require up to 8 feet of cut to prepare this building pad. This will expose a combination of reddish brown silty clay and yellowish brown to yellowish red cherty silty clay at the proposed subgrade elevation, as shown in the Subsurface Fence Diagram in Figure 2. Please note the excavation will remove the fill materials found at Boring No. 3.

Based upon our field and laboratory tests, we recommend the foundations for this building be designed for a net allowable soil bearing pressure of up to 2,000 pounds per square foot (psf) for standard isolated spread footings and conventional wall or strip footings.

All exterior footings in the building should be placed at a minimum depth of 1.5 feet or greater below finished exterior grade for frost protection. Interior footings may be placed at a nominal depth provided they rest on firm natural soil or engineered fill. If any soft, wet, organic or loose soil, or any old fill is encountered at the design foundation elevation, the excavations should be extended downward so that the footings rest on firm soils.

The above stated recommended soil bearing value should be considered an upper limit. Any value less than that listed above will be acceptable for the foundation system, but we recommend the various foundation sections all be designed using the same value to minimize differential settlements within the new structure. Using the value given, predicted total settlement within the building is estimated to be less than 1.0 inch with differential settlements being less than 75 percent of the total.

4.4 Headworks Foundation Recommendations

The proposed elevation for the Headworks structure will require about 6 feet of cut. This will expose reddish brown and yellowish red silty clay at the proposed invert elevation of the Headworks Structure at Elevation 827.0. This will expose the reddish brown and yellowish red silty clays that are illustrated in the Log of Test Boring for Boring No. 5.

Based upon our field and laboratory tests, we recommend the foundations for this building be designed for a net allowable soil bearing pressure of up to 2,000 pounds per square foot (psf) for standard isolated spread footings and conventional wall or strip footings. The foundations will also need to be placed at a minimum depth of 1.5 feet or greater below finished exterior grade for frost protection.

4.5 Aeration and Chlorine Contact Basins Foundation Recommendations

The Aeration Basins will have a proposed invert elevation of Elevation 820.0 with the Contact Basins having a slab elevation of 820.0. The Aeration Basins were explored by Borings No. 6 to 9 with Borings No. 10 and 11 at the Chlorine Contact Basin. The Subsurface Fence Diagram, Figure 3 shows this will require 5 to 10 feet of excavation for the Aeration Basins and 3 to 5 feet of cut at the Chlorine Contact Basin.

The excavation will expose a combination of cherty silty clay silty sand soils at the invert elevation for the Aeration Basins and reddish brown silty clays will be exposed at the Chlorine Contact Basin. The silty sands at Boring No. 7 will also deteriorate easily under any construction traffic.

The silty sands that will be exposed at the Aeration Basins will likely deteriorate easily under any construction traffic. Every effort must be provided to maintain the integrity of the subgrade elevation before the placement of the footing and slab concrete. If any surface deterioration is not properly recompacted, this can result in short term immediate settlements of the structure that cannot be accurately predicted. We recommend this area be undercut one foot below the design subgrade elevation and the undercut excavation be backfilled with surge stone to provide a bridge over these softer soils and eliminate this concern. The surge stone gradation is to have a maximum particle size of 8 inches.

Based upon our field tests, we recommend the foundations for these structures be designed for a net allowable soil bearing pressure of up to 1,000 pounds per square foot (psf) for standard isolated spread footings and conventional wall or strip footings.

The slabs for this structure should be dimensioned using a modulus of subgrade reaction equal to 100 pounds per cubic inch (pci). We also recommend any surge stone and/or gravel supporting the slabs be properly compacted with a medium sized vibratory plate compactor. Otherwise, up to ½ inch or more of settlement can be

expected from the long term consolidation of the gravel if it is not compacted. The use of vibratory compaction equipment larger than a medium sized plate compactor is not recommended as the higher energy output of larger equipment will leave the upper 4 +/- inches of stone loose.

Uplift forces for the buoyant condition during flood conditions can best be resisted by the dead weight of the structure. The installation of soil anchors can be considered; however, their effectiveness is limited by the water table and the high chert content of the supporting soils.

The magnitude of lateral earth pressure against the subsurface portions of the walls during a 100 year flood event will be dependent on the method of backfill placement, the type of backfill soil, drainage provisions and whether or not the wall is permitted to yield after placement of the backfill. It has been demonstrated that, when a wall is held rigidly against horizontal movement, the lateral pressure against the wall is greater than the "active" earth pressure. Therefore, rigid walls should be designed for higher, "at-rest" pressures (K_0), while yielding walls can be designed for active pressures (K_a). For the non-yielding walls, a coefficient of earth pressure at-rest (K_0) of 0.4 is recommended with granular backfill against the wall for drainage purposes. We recommend the walls be designed for an equivalent fluid pressure of 55 pcf, plus any live loading, for those portions of the walls that will be above the high water flood elevation. Below the high water flood elevation, we recommend the lateral loads be based upon a buoyant equivalent fluid pressure of 40 pcf plus the hydrostatic forces.

4.6 Clarifiers Foundation Recommendations

The area for the proposed Clarifiers was explored by Borings No. 12 to 14 and the profile is illustrated in Figure 4. The Clarifiers will have an invert slab elevation of 811.0. This will require up to 16 feet of excavation with the water table at a depth of 14 to 16 feet below the ground surface at Elevation 807 to 812.

The construction of these structures will need to include dewatering the site and excavation bracing that is compatible with minimizing any soil loss from the flowing sand-like soils that will be encountered below Elevation 810. The soils below this elevation have a moisture content that is well above the Liquid Limit of the soil and the chert included in the soil matrix will result in a liquid flow of the soils as they are excavated.

The proximity of the Chlorine Contact Basin to the Clarifiers indicates the loss of soil supporting the Chlorine Contact Basin due to this liquid flow will potentially create significant differential settlement of that structure if it is built before the Clarifiers. Therefore, we recommend the excavation for the Clarifiers and the construction of its excavation bracing be completed before any grading takes place for the Chlorine Contact Basin. This will allow for the repair of any soil loss in that area before the Chlorine Contact Basin is built.

The excavation bracing will need to include methods of limiting the liquid flow of the soils below Elevation 810. These soils may demonstrate a liquid condition under the construction traffic.

Any instability of the subgrade soils can be undercut 2 to 4 feet and then backfilled with surge stone to the design subgrade elevation. The final depth of undercut can be determined at the time of construction.

The structural design recommendations provided in Section 4.5 are recommended for the Clarifiers.

4.7 Aerobic Digester Foundation Recommendations

The Aerobic Digester was explored by Boring No. 15 and the profile is illustrated in Figure 5. The Aerobic Digester will have a finish slab elevation at 818.0. This will require up to 2 feet of excavation to prepare this building pad. Groundwater was found at a depth of 11 feet; however, it is not expected to be a concern for this structure. .

The upper 3 feet of soil in this area is a dark brown colored soil with a silty clay to clayey silt texture. These soils are soft and they may not be suitable to support the proposed foundation loads. It may be necessary to remove the dark brown colored soils from beneath the structure and to backfill the excavation with either a suitable on-site clay soil or surge stone.

The structural design recommendations provided in Section 4.5 are recommended for the Clarifiers.

4.8 Solids Handling Facility Foundation Recommendations

The Solids Handling Facility was explored by Boring No. 16 and the profile is included in Figure 5. This structure will have a finish slab elevation at Elevation 822.0. This will require up to 3 feet of cut and fill to prepare this building pad. Groundwater was found at a depth of 12 feet; however, it is not expected to be a concern for this structure.

The upper 3 to 5 feet of soil in this area is a dark brown colored soil with a sandy silty clay to sandy clayey silt texture. These soils are soft and they may not be suitable to support the proposed foundation loads. It may be necessary to remove the dark brown colored soils from beneath the structure and to backfill the excavation with either a suitable on-site clay soil or surge stone.

We recommend the foundations for this structure be designed for a net allowable soil bearing pressure of up to 1,500 pounds per square foot (psf) for standard isolated spread footings and conventional wall or strip footings. The slabs for this structure should be dimensioned using a modulus of subgrade reaction equal to 100 pounds per cubic inch (pci).

5.0 RECOMMENDED EARTHWORK PROCEDURES

5.1 Site Preparation

All vegetation, topsoil and other organic material or miscellaneous fill and debris should be removed from the construction areas prior to the building or placing of fills. After the completion of the stripping operations and preparation of any proposed fill area, the exposed subgrade areas should be proofrolled. Proofrolling is best achieved during reasonably dry weather using a loaded tandem axle, rubber tire dump truck, or similar approved vehicle, traversing the site in two perpendicular directions. The unsuitable zones identified through this proofroll test should then be replaced with approved fill materials as described in this report.

The surface soils have a silty texture and they were in a moist to very moist condition at the time of this study. The traffic of heavy construction equipment will probably cause pumping and deterioration of the shallower soils with any additional moisture. Therefore, if the grading is carried out during a wet season, subgrade problems can be expected. A quantity of well-graded, crushed stone should consequently be included in the grading contract to be used as needed for replacement and repair of deteriorated subgrade. A "working mat" of crushed stone may also be needed in some areas. The severity of the problems can be field engineered at the time of construction.

5.2 Excavation

We do not anticipate any difficulty will be experienced in excavating the overburden soil on this site with conventional equipment and methods. All final grade excavations and fills should be limited to a 3 horizontal to 1 vertical slope. Also, all excavations should be properly braced or laid back to meet applicable Occupational Safety and Health Administration (OSHA) requirements. Specifically, OSHA classifies these soils as Type C soils. OSHA regulations require the sideslopes of any excavation to be properly braced or laid back on a sideslope of 1.5 horizontal to 1 vertical (1.5:1).

Where laying back the excavated slope is not feasible, excavation bracing will be required. The bracing can be designed using the lateral load coefficients provides in Section 4.2.

We recommend all footing excavations be tested by the geotechnical engineer or his representative to be sure that any excessively loose, soft or otherwise unsuitable materials are removed and that the subgrade soils are satisfactory for foundation support. At the time of testing, it may be necessary to make hand auger borings or to conduct pocket penetrometer or other tests in the base of the foundation excavation. The necessary depth of testing will be established in the field.

5.3 Fill and Compaction

Once the subgrade has been properly prepared, fill may be placed in order to attain the desired final grades. In general, any non-organic soils, such as the soils present at this site, can be used for structural fill. Suitable fill materials for structural fills should consist of a cohesive soil with a Plasticity Index less than 30 and a maximum particle size of 4 inches.

The clayey fill should be placed in lifts of uniform thickness. The lift thickness should not exceed that which can be properly compacted throughout its entire depth with the equipment available, usually no more than 6 inches. We recommend that structural fills supporting footings, floor slabs and pavements be compacted to 95 percent of the Standard Proctor maximum dry density (ASTM D-698). The moisture content of the fill soils should be within plus or minus 3 percent of the optimum moisture content. Density tests shall be performed with a minimum of one test per 6 inch lift per 5,000 to 10,000 square feet with a minimum of two tests regardless of the square footage. The fill placement should be observed and documented by a representative of the geotechnical engineer.

Fill pads should be constructed so that the compacted surface extends horizontally beyond the outside footing edges at least 10 feet and beyond pavements and walks at least 5 feet. The fill slope should also be placed and compacted a minimum of 2 feet beyond the proposed limits and then excavated back to the proposed grades in order to prevent sloughing of the shallow soils on the fill embankment during periods of wet weather.

For proper and timely construction of the fills, the soils should be placed at or near the optimum moisture content as determined by the specified Proctor test. The moisture content of the fill soils should be within plus or minus 3 percent of the optimum moisture content. Suitable equipment for either aerating or adding water to the fill materials should be available as the soil moisture and weather conditions dictate.

We recommend this firm be retained to perform continuous review of any construction of the soils related phases of this project. Otherwise, we assume no responsibility for construction compliance with the design concepts, specifications, or our recommendations. As a part of this review, field density tests should be performed as frequently as necessary to assist in the evaluation of the fill with respect to the above recommendations.

5.4 Construction Dewatering

At the time of our study, the water table was found to vary between Elevation 805 to 812. No excavations are proposed below these elevations.

Should a seasonal groundwater table above those noted on the Logs of Test Boring be found, dewatering procedures and excavation bracing may be required. The primary concern will be with potential soil loss from the flowing sand-like soils that may be saturated.

The sandy and cherty soils have a relatively high permeability that can only be quantified by a slug test or a pump test. The scope of this study did not include the construction of monitoring wells for long term groundwater measurements and/or pump tests.

6.0 LIMITATIONS OF STUDY

Our recommendations for this report were developed utilizing subsurface information obtained from the test borings performed. At this time, we would like to point out that exploratory test borings only depict the subsurface conditions at the specific location and time at which they were made. The subsurface conditions at other locations on the site may differ from those occurring at the test boring locations; however, only minor variations that can readily be evaluated and adjusted for during construction are expected.

The conclusions and recommendations herein have been based upon the available subsurface information and the assumptions previously stated and the preliminary design details furnished by the engineer of the proposed project. We recommend that we be given the opportunity to review the final design plans and specification as they relate to the recommendations presented in this report. The purpose of this review is to determine that the conclusions and recommendations presented herein have been properly incorporated into the final design. Any revision in the plans for the proposed structure from those anticipated in this report should also be brought to the attention of the geotechnical engineer so that he may determine whether any changes in the foundation recommendations are necessary. Unanticipated conditions encountered during construction of the project should be reported to this office in order to provide timely recommendations to solve the problems encountered.

The scope of our services does not include any environmental assessment or investigation for the presence of absence of hazardous or toxic materials in the soil, groundwater or surface water within or beyond the site studied. Any statements in this report or on the test boring logs regarding odors, staining of soils or other unusual conditions observed are strictly for the information of our client.

Our professional services have been performed, our findings obtained, and our recommendations prepared in accordance with generally accepted geotechnical engineering principles and practice. This company is not responsible for the conclusions, opinions, or recommendations made by others based upon the data included herein.

APPENDIX

Figure 1 - Boring Location Plan

Figure 2 - Subsurface Fence Diagram, Lab/Office Building

Figure 3 - Subsurface Fence Diagram, Aeration and Chlorine Contact Basins

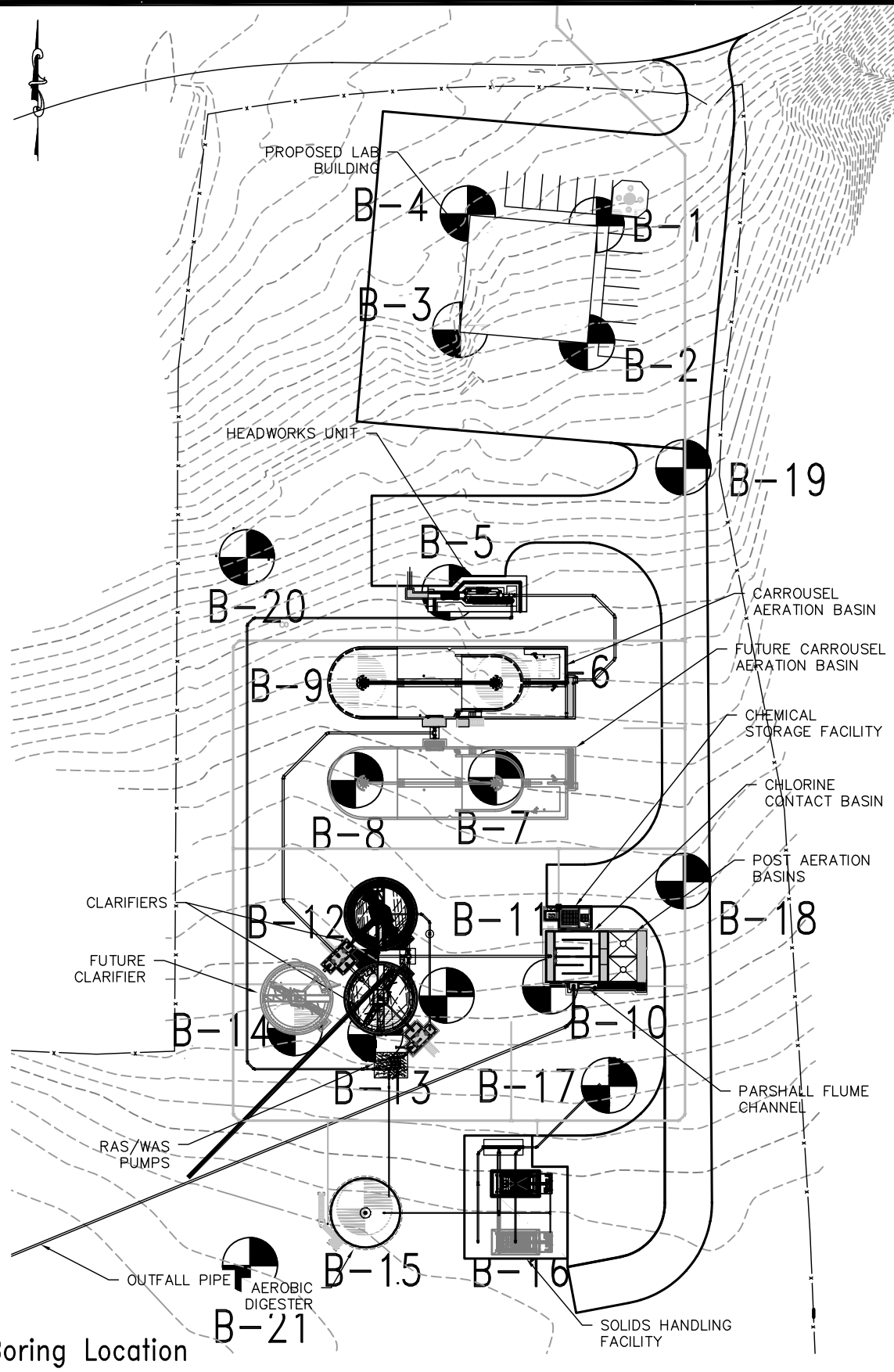
Figure 4 - Subsurface Fence Diagram, Clarifiers

Figure 5 - Subsurface Fence Diagram, Aerobic Digester, Solids Handling Facility

Logs of Test Boring

Field Classification System for Soil Exploration

Important Information About This Geotechnical
Engineering Report



BORING LOCATION PLAN

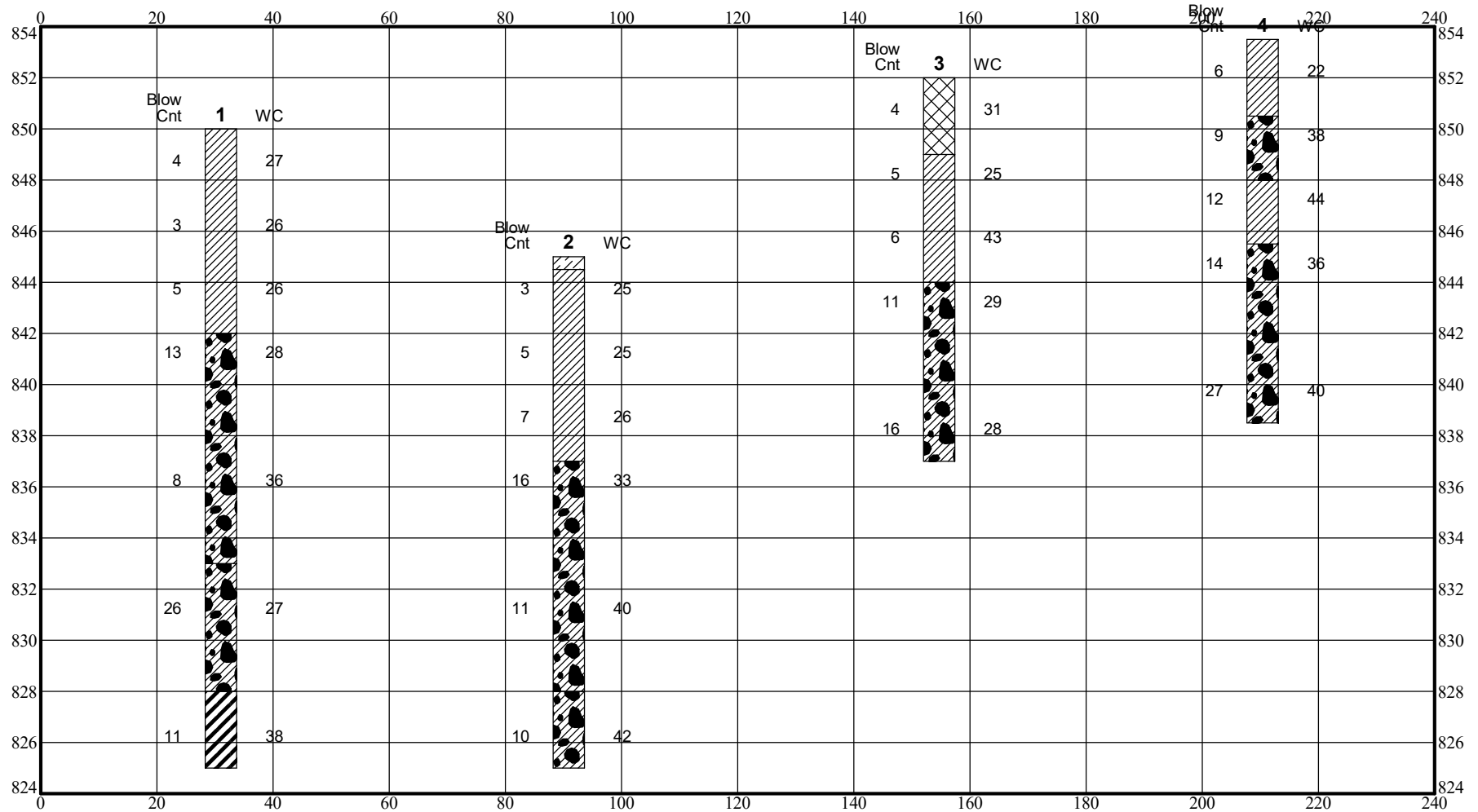
Pikeville WWTP
 Pikeville, Tennessee

PROJECT NO.
 2022-070

SCALE
 1" = 80'

FIGURE NO.
 1





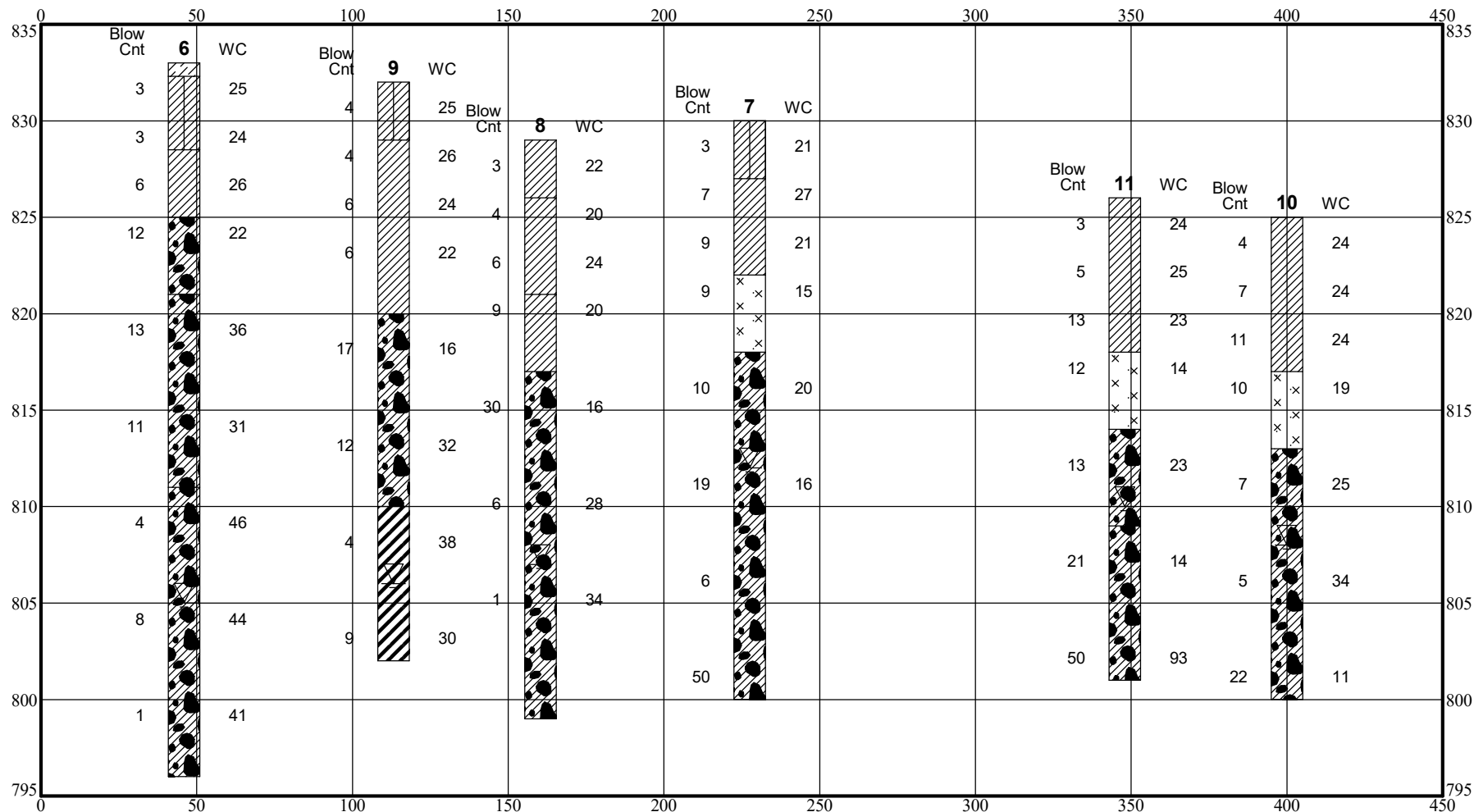
Boring	North	East	Elev.	Depth
1	460825.0	2208584.0	850.0	25.0
2	460768.0	2208577.0	845.0	20.0
3	460777.0	2208513.0	852.0	15.0
4	460832.0	2208522.0	853.5	15.0

NOTE - Fence diagram graphics match the graphics shown on the boring logs.

DISTANCES:
 Beginning 0.0
 Ending 240.0
 VIEWING ANGLES (degrees):
 Horizontal 0.0
 Vertical 0.0

Position	North	East
Left, Front	460855.45	2208590.60
Right, Front	460861.44	2208525.40
Left, Back	460855.45	2208590.60
Right, Back	460861.44	2208525.40

SUBSURFACE FENCE DIAGRAM		
Lab/Office Building		
New 0.366 MGD WWTP		
Pikeville, Tennessee		
PROJECT #	DATE	FIGURE
2022-070	Jan 23	2



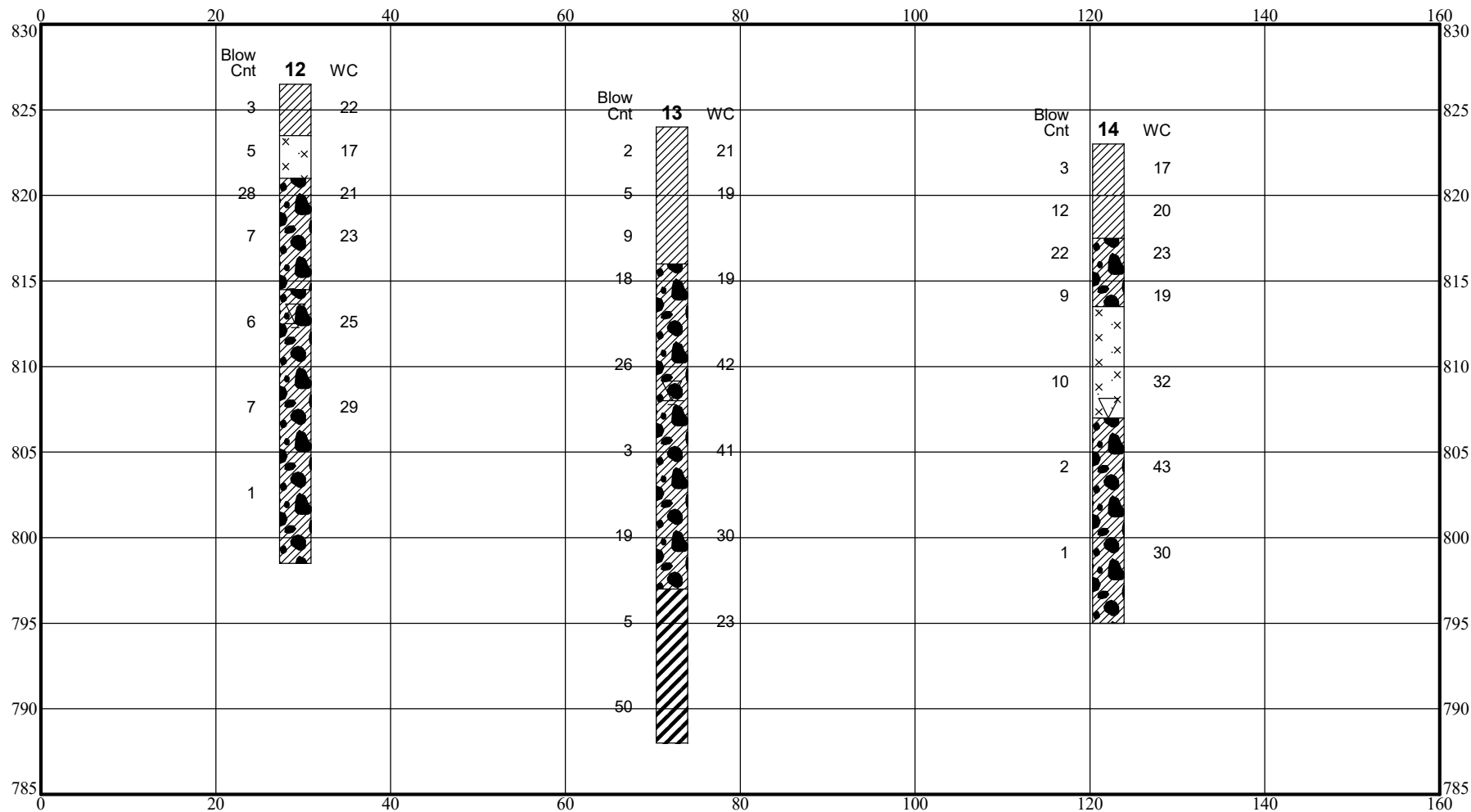
Boring	North	East	Elev.	Depth
6	460596.0	2208522.0	833.0	37.0
7	460546.0	2208519.0	830.0	30.0
8	460550.0	2208452.0	829.0	30.0
9	460600.0	2208452.0	832.0	30.0
10	460436.0	2208539.0	825.0	25.0
11	460438.0	2208487.0	826.0	25.0

NOTE - Fence diagram graphics match the graphics shown on the boring logs.

DISTANCES:
 Beginning 0.0
 Ending 450.0
 VIEWING ANGLES (degrees):
 Horizontal 0.0
 Vertical 0.0

Position	North	East
Left, Front	460593.23	2208567.83
Right, Front	460433.75	2208588.94
Left, Back	460593.23	2208567.83
Right, Back	460433.75	2208588.94

SUBSURFACE FENCE DIAGRAM		
Aeration and Chlorine Contact Basins		
New 0.366 MGD WWTP		
Pikeville, Tennessee		
PROJECT #	DATE	FIGURE
2022-070	Jan 23	3



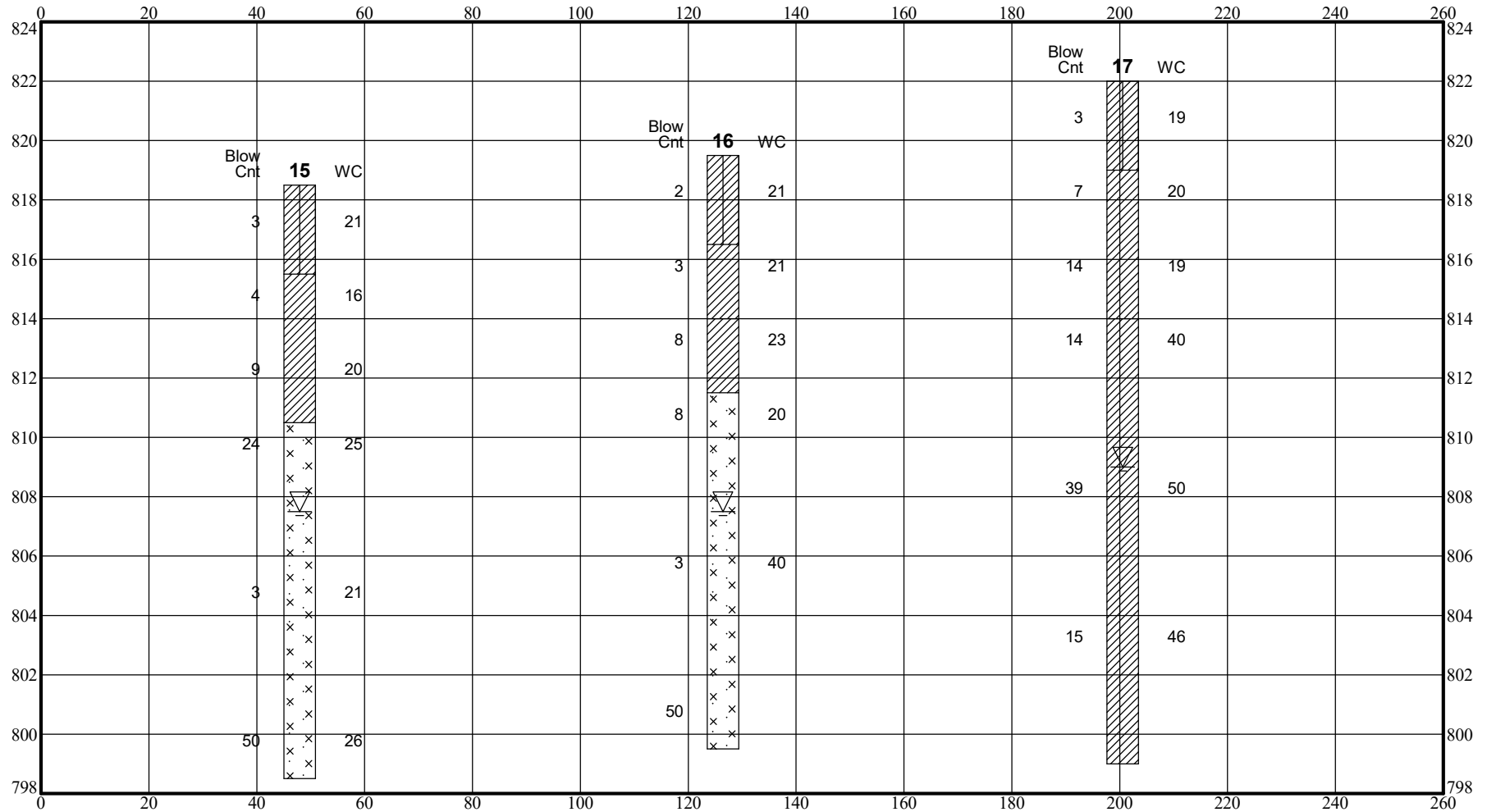
Boring	North	East	Elev.	Depth
12	460462.0	2208458.0	826.5	28.0
13	460419.0	2208455.0	824.0	36.0
14	460422.0	2208409.0	823.0	28.0

NOTE - Fence diagram graphics match the graphics shown on the boring logs.

DISTANCES:
 Beginning 0.0
 Ending 160.0
 VIEWING ANGLES (degrees):
 Horizontal 0.0
 Vertical 0.0

Position	North	East
Left, Front	460491.08	2208459.01
Right, Front	460425.13	2208371.23
Left, Back	460491.08	2208459.01
Right, Back	460425.13	2208371.23

SUBSURFACE FENCE DIAGRAM		
Clarifiers		
New 0.366 MGD WWTP		
Pikeville, Tennessee		
PROJECT #	DATE	FIGURE
2022-070	Feb 23	4



Boring	North	East	Elev.	Depth
15	460328.0	2208442.0	818.5	20.0
16	460337.0	2208520.0	819.5	20.0
17	460389.0	2208571.0	822.0	23.0

NOTE - Fence diagram graphics match the graphics shown on the boring logs.

DISTANCES:
 Beginning 0.0
 Ending 260.0
 VIEWING ANGLES (degrees):
 Horizontal 0.0
 Vertical 0.0

Position	North	East
Left, Front	460331.93	2208394.20
Right, Front	460434.89	2208608.80
Left, Back	460331.93	2208394.20
Right, Back	460434.89	2208608.80

SUBSURFACE FENCE DIAGRAM		
Aerobic Digester and Solids Handling Facility		
New 0.366 MGD WWTP		
Pikeville, Tennessee		
PROJECT #	DATE	FIGURE
2022-070	Apr 23	5



Client Hussey Gay Bell Boring # 1
 Architect/Engineer _____ Job # 2022-070
 Project Name New 0.366 MGD WWTP Drawn By RTS
 Project Location Pikeville, Tennessee Approved By RTS

TEST DATA

DRILLING AND SAMPLING INFORMATION

Date Started 1/17/23 Hammer Wt. 140 Auto lbs.
 Date Completed 1/17/23 Hammer Drop 30 in.
 Drill Foreman SOUTH BROS Spoon Sampler O.D. 2 in.
 Inspector _____ Rock Core Dia. _____ in.
 Boring Method HSA Shelby Tube O.D. _____ in.

SOIL CLASSIFICATION	STRATUM DEPTH	DEPTH SCALE	LITH- OLOGY	SAMPLE NO.	SAMPLE TYPE	Standard Penetration Test N. Blows/Ft.	Unconfined Compressive Strength Tons/Ft. ²	Pocket Penetrometer Tons/Ft. ²	Natural Dry Density lbs/cu. ft.	Water Content %	Atterberg Limits LL - Liquid Limit PL - Plastic Limit
Reddish brown silty clay, with trace fine grained sand, moist, soft to medium stiff.				1	SS	4				26.9	
		5		2	SS	3				26.4	
	8.0			3	SS	5				26.0	LL=36 PL=18
Yellowish brown and yellowish red cherty silty clay, moist, medium stiff.	842.0	10		4	SS	13		4.5+		27.6	
		15		5	SS	8		4.5+		36.2	
Yellowish brown and yellowish red dense chert and silty clay, moist, very stiff.	17.0 833.0	20		6	SS	26				27.3	
	22.0										
Yellowish brown silty clay, with some chert, moist, stiff.	828.0	25		7	SS	11		2.0		38.0	
Test boring discontinued at the planned exploration depth of 25.0 feet.	825.0										
		30									
		35									
		40									

SAMPLER TYPE
 SS - DRIVEN SPLIT SPOON
 ST - PRESSED SHELBY TUBE
 CA - CONTINUOUS FLIGHT AUGER
 RC - ROCK CORE

GROUND WATER DEPTH
 ▽ AT COMPLETION Dry FT.
 ▽ AFTER _____ FT.
 WATER ON RODS _____ FT.

BORING METHOD
 HSA - HOLLOW STEM AUGERS
 CFA - CONTINUOUS FLIGHT AUGERS
 DC - DRIVING CASING
 RW - ROTARY WASH



Client Hussey Gay Bell Boring # 2
 Architect/Engineer _____ Job # 2022-070
 Project Name New 0.366 MGD WWTP Drawn By RTS
 Project Location Pikeville, Tennessee Approved By RTS

TEST DATA

DRILLING AND SAMPLING INFORMATION

Date Started 1/17/23 Hammer Wt. 140 Auto lbs.
 Date Completed 1/17/23 Hammer Drop 30 in.
 Drill Foreman SOUTH BROS Spoon Sampler O.D. 2 in.
 Inspector _____ Rock Core Dia. _____ in.
 Boring Method HSA Shelby Tube O.D. _____ in.

SOIL CLASSIFICATION	STRATUM DEPTH	DEPTH SCALE	LITH- OLOGY	SAMPLE NO.	SAMPLE TYPE	Standard Penetration Test N. Blows/Ft.	Unconfined Compressive Strength Tons/Ft. ²	Pocket Penetrometer Tons/Ft. ²	Natural Dry Density lbs/cu. ft.	Water Content %	Atterberg Limits LL - Liquid Limit PL - Plastic Limit
Topsoil	0.5										
Reddish brown silty clay, with trace fine grained sand, moist, soft to medium stiff.	844.5			1	SS	3				25.2	
		5		2	SS	5				24.6	
				3	SS	7		2.0		26.0	
Yellowish brown and yellowish red cherty silty clay, moist, stiff.	8.0										
	837.0	10		4	SS	16		4.5+		32.8	
Yellowish brown and yellowish red chert and silty clay, moist, medium stiff.		15		5	SS	11				40.2	
	17.0										
Test boring discontinued at the planned exploration depth of 20.0 feet.	828.0			6	SS	10				41.5	
	20.0	20									
	825.0										
		25									
		30									
		35									
		40									

SAMPLER TYPE: SS - DRIVEN SPLIT SPOON, ST - PRESSED SHELBY TUBE, CA - CONTINUOUS FLIGHT AUGER, RC - ROCK CORE
 GROUND WATER DEPTH: AT COMPLETION Dry FT., AFTER _____ FT., WATER ON RODS _____ FT.
 BORING METHOD: HSA - HOLLOW STEM AUGERS, CFA - CONTINUOUS FLIGHT AUGERS, DC - DRIVING CASING, RW - ROTARY WASH



Client Hussey Gay Bell Boring # 3
 Architect/Engineer _____ Job # 2022-070
 Project Name New 0.366 MGD WWTP Drawn By RTS
 Project Location Pikeville, Tennessee Approved By RTS

TEST DATA

DRILLING AND SAMPLING INFORMATION

Date Started 1/17/23 Hammer Wt. 140 Auto lbs.
 Date Completed 1/17/23 Hammer Drop 30 in.
 Drill Foreman SOUTH BROS Spoon Sampler O.D. 2 in.
 Inspector _____ Rock Core Dia. _____ in.
 Boring Method HSA Shelby Tube O.D. _____ in.

SOIL CLASSIFICATION	STRATUM DEPTH	DEPTH SCALE	LITH- OLOGY	SAMPLE NO.	SAMPLE TYPE	Standard Penetration Test N. Blows/Ft.	Unconfined Compressive Strength Tons/Ft. ²	Pocket Penetrometer Tons/Ft. ²	Natural Dry Density lbs/cu. ft.	Water Content %	Atterberg Limits LL - Liquid Limit PL - Plastic Limit
FILL - Dark brown and brown cherty silty clay. very moist, medium stiff.	3.0			1	SS	4				31.4	
Reddish brown silty clay, with trace fine grained sand, moist, medium stiff.	8.0	5		2	SS	5				24.8	
				3	SS	6				42.6	
Yellowish brown and yellowish red dense chert and silty clay, moist, very stiff.	8.0	10		4	SS	11		4.0		29.1	
				5	SS	16		3.5		28.4	
Test boring discontinued at the planned exploration depth of 15.0 feet.	15.0	15									

SAMPLER TYPE: SS - DRIVEN SPLIT SPOON, ST - PRESSED SHELBY TUBE, CA - CONTINUOUS FLIGHT AUGER, RC - ROCK CORE
 GROUND WATER DEPTH: AT COMPLETION Dry FT., AFTER _____ FT., WATER ON RODS _____ FT.
 BORING METHOD: HSA - HOLLOW STEM AUGERS, CFA - CONTINUOUS FLIGHT AUGERS, DC - DRIVING CASING, RW - ROTARY WASH



Client Hussey Gay Bell Boring # 4
 Architect/Engineer _____ Job # 2022-070
 Project Name New 0.366 MGD WWTP Drawn By RTS
 Project Location Pikeville, Tennessee Approved By RTS

TEST DATA

DRILLING AND SAMPLING INFORMATION

Date Started 1/17/23 Hammer Wt. 140 Auto lbs.
 Date Completed 1/17/23 Hammer Drop 30 in.
 Drill Foreman SOUTH BROS Spoon Sampler O.D. 2 in.
 Inspector _____ Rock Core Dia. _____ in.
 Boring Method HSA Shelby Tube O.D. _____ in.

SOIL CLASSIFICATION	STRATUM DEPTH	DEPTH SCALE	LITH- OLOGY	SAMPLE NO.	SAMPLE TYPE	Standard Penetration Test N. Blows/Ft.	Unconfined Compressive Strength Tons/Ft. ²	Pocket Penetrometer Tons/Ft. ²	Natural Dry Density lbs/cu. ft.	Water Content %	Atterberg Limits LL - Liquid Limit PL - Plastic Limit
Brown silty clay, with trace fine grained sand, moist, medium stiff.	3.0			1	SS	6				22.2	
Yellowish brown and yellowish red cherty silty clay, moist, medium stiff.	5.5	5		2	SS	9				37.8	
Yellowish red silty clay, with trace chert, moist, stiff.	8.0			3	SS	12		4.0		43.6	
Yellowish brown and yellowish red dense chert and silty clay, moist, stiff to very stiff.	10.0	10		4	SS	14				36.5	
	15.0	15		5	SS	27				40.0	
Test boring discontinued at the planned exploration depth of 15.0 feet.	15.0	15									

SAMPLER TYPE
 SS - DRIVEN SPLIT SPOON
 ST - PRESSED SHELBY TUBE
 CA - CONTINUOUS FLIGHT AUGER
 RC - ROCK CORE

GROUND WATER DEPTH
 ▽ AT COMPLETION Dry FT.
 ▽ AFTER _____ FT.
 WATER ON RODS _____ FT.

BORING METHOD
 HSA - HOLLOW STEM AUGERS
 CFA - CONTINUOUS FLIGHT AUGERS
 DC - DRIVING CASING
 RW - ROTARY WASH



Client Hussey Gay Bell Boring # 5
 Architect/Engineer _____ Job # 2022-070
 Project Name New 0.366 MGD WWTP Drawn By RTS
 Project Location Pikeville, Tennessee Approved By RTS

TEST DATA

DRILLING AND SAMPLING INFORMATION

Date Started 1/17/23 Hammer Wt. 140 Auto lbs.
 Date Completed 1/17/23 Hammer Drop 30 in.
 Drill Foreman SOUTH BROS Spoon Sampler O.D. 2 in.
 Inspector _____ Rock Core Dia. _____ in.
 Boring Method HSA Shelby Tube O.D. _____ in.

SOIL CLASSIFICATION	STRATUM DEPTH	DEPTH SCALE	LITH- OLOGY	SAMPLE NO.	SAMPLE TYPE	Standard Penetration Test N. Blows/Ft.	Unconfined Compressive Strength Tons/Ft. ²	Pocket Penetrometer Tons/Ft. ²	Natural Dry Density lbs/cu. ft.	Water Content %	Atterberg Limits LL - Liquid Limit PL - Plastic Limit
Brown silty clay, with trace fine grained sand, moist to very moist, soft.	3.0			1	SS	3				22.4	
Reddish brown silty clay, with trace fine grained sand, moist, soft.	832.0	5		2	SS	3				25.1	
				3	SS	5				26.4	
				4	SS	5				24.1	
				10							
Reddish brown and yellowish red silty clay, with trace chert, moist, stiff.	12.0			5	SS	13				21.3	
Yellowish brown and yellowish red cherty silty clay, moist, medium stiff.	818.0	20		6	SS	18				46.3	
		25		7	SS	10				29.6	
Very dense chert below 28 feet.											
Test boring discontinued at the planned exploration depth of 30.0 feet.	30.0			8	SS	8				15.7	
	805.0	30									
		35									
		40									

SAMPLER TYPE
 SS - DRIVEN SPLIT SPOON
 ST - PRESSED SHELBY TUBE
 CA - CONTINUOUS FLIGHT AUGER
 RC - ROCK CORE

GROUND WATER DEPTH
 ▽ AT COMPLETION 28.0 FT.
 ▽ AFTER _____ FT.
 WATER ON RODS 28.0 FT.

BORING METHOD
 HSA - HOLLOW STEM AUGERS
 CFA - CONTINUOUS FLIGHT AUGERS
 DC - DRIVING CASING
 RW - ROTARY WASH



Client Hussey Gay Bell Boring # 6
 Architect/Engineer _____ Job # 2022-070
 Project Name New 0.366 MGD WWTP Drawn By RTS
 Project Location Pikeville, Tennessee Approved By RTS

TEST DATA

DRILLING AND SAMPLING INFORMATION

Date Started 1/17/23 Hammer Wt. 140 Auto lbs.
 Date Completed 1/17/23 Hammer Drop 30 in.
 Drill Foreman SOUTH BROS Spoon Sampler O.D. 2 in.
 Inspector _____ Rock Core Dia. _____ in.
 Boring Method HSA Shelby Tube O.D. _____ in.

SOIL CLASSIFICATION	STRATUM DEPTH	DEPTH SCALE	LITH- OLOGY	SAMPLE NO.	SAMPLE TYPE	Standard Penetration Test N. Blows/Ft.	Unconfined Compressive Strength Tons/Ft. ²	Pocket Penetrometer Tons/Ft. ²	Natural Dry Density lbs/cu. ft.	Water Content %	Atterberg Limits LL - Liquid Limit PL - Plastic Limit
SURFACE ELEVATION - 833.0											
Topsoil	0.7										
Dark brown silty clay to clayey silt, with trace organics, moist, soft.	832.3			1	SS	3				24.9	
	4.5			2	SS	3				23.5	
Reddish brown silty clay, with trace fine grained sand, moist, soft to medium stiff.	828.5	5		3	SS	6				25.5	
	8.0			4	SS	12				22.3	
Yellowish brown and yellowish red cherty silty clay, moist, stiff.	825.0	10		4	SS	12					
	12.0			5	SS	13		4.0		36.2	LL=63 PL=30
Yellowish red to yellowish brown silty clay, with some chert, moist, stiff.	821.0	15		5	SS	13					
	20			6	SS	11				31.1	
	22.0			7	SS	4				45.5	
Yellowish red to yellowish brown and gray silty clay, with some chert, very moist, soft to very soft.	811.0	25		7	SS	4					
	30			8	SS	8				44.0	
	35			9	SS	1				41.3	
Test boring discontinued at 37.0 feet at auger refusal.	37.0										
	796.0										

SAMPLER TYPE
 SS - DRIVEN SPLIT SPOON
 ST - PRESSED SHELBY TUBE
 CA - CONTINUOUS FLIGHT AUGER
 RC - ROCK CORE

GROUND WATER DEPTH
 ▽ AT COMPLETION 28.0 FT.
 ▽ AFTER _____ FT.
 WATER ON RODS 28.0 FT.

BORING METHOD
 HSA - HOLLOW STEM AUGERS
 CFA - CONTINUOUS FLIGHT AUGERS
 DC - DRIVING CASING
 RW - ROTARY WASH



Client Hussey Gay Bell Boring # 7
 Architect/Engineer _____ Job # 2022-070
 Project Name New 0.366 MGD WWTP Drawn By RTS
 Project Location Pikeville, Tennessee Approved By RTS

TEST DATA

DRILLING AND SAMPLING INFORMATION

Date Started 1/17/23 Hammer Wt. 140 Auto lbs.
 Date Completed 1/17/23 Hammer Drop 30 in.
 Drill Foreman SOUTH BROS Spoon Sampler O.D. 2 in.
 Inspector _____ Rock Core Dia. _____ in.
 Boring Method HSA Shelby Tube O.D. _____ in.

SOIL CLASSIFICATION	STRATUM DEPTH	DEPTH SCALE	LITH- OLOGY	SAMPLE NO.	SAMPLE TYPE	Standard Penetration Test N. Blows/Ft.	Unconfined Compressive Strength Tons/Ft. ²	Pocket Penetrometer Tons/Ft. ²	Natural Dry Density lbs/cu. ft.	Water Content %	Atterberg Limits LL - Liquid Limit PL - Plastic Limit
Dark brown silty clay to clayey silt, with trace organics, moist, soft.	3.0			1	SS	3				21.2	
Reddish brown silty clay, with trace fine grained sand, moist, medium stiff.	827.0	5		2	SS	7				26.9	
	8.0			3	SS	9				21.1	
	822.0	10		4	SS	9				14.9	
Yellowish red fine grained silty sand, moist, loose.	12.0			5	SS	10				19.9	
Brown and yellowish brown silty clay, with some chert, moist to very moist below 18 feet, medium stiff to very stiff.	818.0	15		6	SS	19				16.1	
		20		7	SS	6					
		25		8	SS	50/0.4'					
Test boring discontinued at the planned exploration depth of 30.0 feet.	30.0	30									
	800.0	35									
		40									

SAMPLER TYPE
 SS - DRIVEN SPLIT SPOON
 ST - PRESSED SHELBY TUBE
 CA - CONTINUOUS FLIGHT AUGER
 RC - ROCK CORE

GROUND WATER DEPTH
 ▽ AT COMPLETION 18.0 FT.
 ▽ AFTER _____ FT.
 WATER ON RODS 18.0 FT.

BORING METHOD
 HSA - HOLLOW STEM AUGERS
 CFA - CONTINUOUS FLIGHT AUGERS
 DC - DRIVING CASING
 RW - ROTARY WASH



Client Hussey Gay Bell Boring # 8
 Architect/Engineer _____ Job # 2022-070
 Project Name New 0.366 MGD WWTP Drawn By RTS
 Project Location Pikeville, Tennessee Approved By RTS

TEST DATA

DRILLING AND SAMPLING INFORMATION

Date Started 1/17/23 Hammer Wt. 140 Auto lbs.
 Date Completed 1/17/23 Hammer Drop 30 in.
 Drill Foreman SOUTH BROS Spoon Sampler O.D. 2 in.
 Inspector _____ Rock Core Dia. _____ in.
 Boring Method HSA Shelby Tube O.D. _____ in.

SOIL CLASSIFICATION	STRATUM DEPTH	DEPTH SCALE	LITH- OLOGY	SAMPLE NO.	SAMPLE TYPE	Standard Penetration Test N. Blows/Ft.	Unconfined Compressive Strength Tons/Ft. ²	Pocket Penetrometer Tons/Ft. ²	Natural Dry Density lbs/cu. ft.	Water Content %	Atterberg Limits LL - Liquid Limit PL - Plastic Limit
SURFACE ELEVATION - 829.0											
Brown silty clay, moist, soft.	3.0			1	SS	3				21.7	
Reddish brown silty clay, with trace fine grained sand, moist, medium stiff.	826.0	5		2	SS	4				20.2	
	8.0			3	SS	6				23.6	
	821.0	10		4	SS	9				20.4	
Reddish brown to yellowish brown sandy silty clay, moist, medium stiff.	12.0			5	SS	30				15.8	
Brown silty clay, with some chert, moist to very moist below 20 feet, very stiff grading to very soft below 22 feet.	817.0	15		6	SS	6				27.5	
		20		7	SS	1				34.2	
		25									
Test boring discontinued at the planned exploration depth of 30.0 feet.	30.0	30									
	799.0										
		35									
		40									

SAMPLER TYPE
 SS - DRIVEN SPLIT SPOON
 ST - PRESSED SHELBY TUBE
 CA - CONTINUOUS FLIGHT AUGER
 RC - ROCK CORE

GROUND WATER DEPTH
 ▽ AT COMPLETION 22.0 FT.
 ▽ AFTER _____ FT.
 WATER ON RODS 22.0 FT.

BORING METHOD
 HSA - HOLLOW STEM AUGERS
 CFA - CONTINUOUS FLIGHT AUGERS
 DC - DRIVING CASING
 RW - ROTARY WASH



Client Hussey Gay Bell Boring # 9
 Architect/Engineer _____ Job # 2022-070
 Project Name New 0.366 MGD WWTP Drawn By RTS
 Project Location Pikeville, Tennessee Approved By RTS

TEST DATA

DRILLING AND SAMPLING INFORMATION

Date Started 1/17/23 Hammer Wt. 140 Auto lbs.
 Date Completed 1/17/23 Hammer Drop 30 in.
 Drill Foreman SOUTH BROS Spoon Sampler O.D. 2 in.
 Inspector _____ Rock Core Dia. _____ in.
 Boring Method HSA Shelby Tube O.D. _____ in.

SOIL CLASSIFICATION	STRATUM DEPTH	DEPTH SCALE	LITH- OLOGY	SAMPLE NO.	SAMPLE TYPE	Standard Penetration Test N. Blows/Ft.	Unconfined Compressive Strength Tons/Ft. ²	Pocket Penetrometer Tons/Ft. ²	Natural Dry Density lbs/cu. ft.	Water Content %	Atterberg Limits LL - Liquid Limit PL - Plastic Limit
Brown silty clay to clayey silt, moist, medium stiff.	3.0			1	SS	4				24.7	
Dark reddish brown silty clay, with trace fine grained sand, moist, medium stiff.	829.0	5		2	SS	4				25.6	
				3	SS	6				23.8	
				4	SS	6				22.1	
		10		4	SS	6				22.1	
Yellowish brown and yellowish red cherty silty clay, moist, very stiff.	820.0	15		5	SS	17				16.1	
		20		6	SS	12				32.2	
		22.0		6	SS	12				32.2	
Yellowish brown and yellowish red silty clay, with some chert, very moist to wet, medium stiff to stiff.	810.0	25		7	SS	4				38.0	
		30.0		7	SS	4				38.0	
Test boring discontinued at the planned exploration depth of 30.0 feet.	802.0	30		8	SS	9				29.9	

SAMPLER TYPE
 SS - DRIVEN SPLIT SPOON
 ST - PRESSED SHELBY TUBE
 CA - CONTINUOUS FLIGHT AUGER
 RC - ROCK CORE

GROUND WATER DEPTH
 ▽ AT COMPLETION 26.0 FT.
 ▽ AFTER _____ FT.
 WATER ON RODS 26.0 FT.

BORING METHOD
 HSA - HOLLOW STEM AUGERS
 CFA - CONTINUOUS FLIGHT AUGERS
 DC - DRIVING CASING
 RW - ROTARY WASH



Client Hussey Gay Bell Boring # 10
 Architect/Engineer _____ Job # 2022-070
 Project Name New 0.366 MGD WWTP Drawn By RTS
 Project Location Pikeville, Tennessee Approved By RTS

TEST DATA

DRILLING AND SAMPLING INFORMATION

Date Started 1/17/23 Hammer Wt. 140 Auto lbs.
 Date Completed 1/17/23 Hammer Drop 30 in.
 Drill Foreman SOUTH BROS Spoon Sampler O.D. 2 in.
 Inspector _____ Rock Core Dia. _____ in.
 Boring Method HSA Shelby Tube O.D. _____ in.

SOIL CLASSIFICATION	STRATUM DEPTH	DEPTH SCALE	LITH- OLOGY	SAMPLE NO.	SAMPLE TYPE	Standard Penetration Test N. Blows/Ft.	Unconfined Compressive Strength Tons/Ft. ²	Pocket Penetrometer Tons/Ft. ²	Natural Dry Density lbs/cu. ft.	Water Content %	Atterberg Limits LL - Liquid Limit PL - Plastic Limit
Reddish brown silty clay, with trace fine grained sand, moist, soft to medium stiff.	8.0	5		1	SS	4				24.4	LL=33 PL=21
				2	SS	7				23.7	
				3	SS	11				24.3	
Reddish yellow to yellowish red fine grained silty sand, moist, loose.	817.0	10		4	SS	10				18.5	
				5	SS	7				25.0	
Yellowish brown and yellowish red dense chert and silty clay, very moist to wet, medium stiff to very stiff.	813.0	15		6	SS	5				34.4	
				7	SS	22				11.4	
Test boring discontinued at the planned exploration depth of 25.0 feet.	800.0	25									
		30									
		35									
		40									

SAMPLER TYPE
 SS - DRIVEN SPLIT SPOON
 ST - PRESSED SHELBY TUBE
 CA - CONTINUOUS FLIGHT AUGER
 RC - ROCK CORE

GROUND WATER DEPTH
 ▽ AT COMPLETION 17.0 FT.
 ▽ AFTER _____ FT.
 WATER ON RODS 17.0 FT.

BORING METHOD
 HSA - HOLLOW STEM AUGERS
 CFA - CONTINUOUS FLIGHT AUGERS
 DC - DRIVING CASING
 RW - ROTARY WASH



Client Hussey Gay Bell Boring # 11
 Architect/Engineer _____ Job # 2022-070
 Project Name New 0.366 MGD WWTP Drawn By RTS
 Project Location Pikeville, Tennessee Approved By RTS

TEST DATA

DRILLING AND SAMPLING INFORMATION

Date Started 1/17/23 Hammer Wt. 140 Auto lbs.
 Date Completed 1/17/23 Hammer Drop 30 in.
 Drill Foreman SOUTH BROS Spoon Sampler O.D. 2 in.
 Inspector _____ Rock Core Dia. _____ in.
 Boring Method HSA Shelby Tube O.D. _____ in.

SOIL CLASSIFICATION	STRATUM DEPTH	DEPTH SCALE	LITH- OLOGY	SAMPLE NO.	SAMPLE TYPE	Standard Penetration Test N. Blows/Ft.	Unconfined Compressive Strength Tons/Ft. ²	Pocket Penetrometer Tons/Ft. ²	Natural Dry Density lbs/cu. ft.	Water Content %	Atterberg Limits LL - Liquid Limit PL - Plastic Limit
Reddish brown silty clay, with trace fine grained sand and trace chert below 5 feet, moist, soft to medium stiff.	8.0	5		1	SS	3				23.9	
				2	SS	5				25.4	
				3	SS	13				23.4	
Yellowish red fine grained silty sand, moist, loose.	818.0	10		4	SS	12				14.4	
	12.0										
Yellowish brown and yellowish red cherty silty clay, moist, stiff to very stiff.	814.0	15		5	SS	13				23.4	
	17.0										
Yellowish brown and yellowish red dense chert and silty clay, wet, soft.	809.0	20		6	SS	21				13.8	
	25.0										
Test boring discontinued at the planned exploration depth of 25.0 feet.	801.0	25		7	SS	50/0.7'				92.9	
		30									
		35									
		40									

SAMPLER TYPE: SS - DRIVEN SPLIT SPOON, ST - PRESSED SHELBY TUBE, CA - CONTINUOUS FLIGHT AUGER, RC - ROCK CORE
 GROUND WATER DEPTH: AT COMPLETION 16.0 FT., AFTER _____ FT., WATER ON RODS 16.0 FT.
 BORING METHOD: HSA - HOLLOW STEM AUGERS, CFA - CONTINUOUS FLIGHT AUGERS, DC - DRIVING CASING, RW - ROTARY WASH



Client Hussey Gay Bell Boring # 12
 Architect/Engineer _____ Job # 2022-070
 Project Name New 0.366 MGD WWTP Drawn By RTS
 Project Location Pikeville, Tennessee Approved By RTS

TEST DATA

DRILLING AND SAMPLING INFORMATION

Date Started 1/17/23 Hammer Wt. 140 Auto lbs.
 Date Completed 1/17/23 Hammer Drop 30 in.
 Drill Foreman SOUTH BROS Spoon Sampler O.D. 2 in.
 Inspector _____ Rock Core Dia. _____ in.
 Boring Method HSA Shelby Tube O.D. _____ in.

SOIL CLASSIFICATION	STRATUM DEPTH	DEPTH SCALE	LITH- OLOGY	SAMPLE NO.	SAMPLE TYPE	Standard Penetration Test N. Blows/Ft.	Unconfined Compressive Strength Tons/Ft. ²	Pocket Penetrometer Tons/Ft. ²	Natural Dry Density lbs/cu. ft.	Water Content %	Atterberg Limits LL - Liquid Limit PL - Plastic Limit
Reddish brown sandy silty clay, moist, soft.	3.0			1	SS	3				22.0	
Yellowish brown to brown fine grained silty sand, moist, very loose.	823.5	5		2	SS	5				17.1	
Brown cherty silty clay, moist, very stiff grading to medium stiff.	821.0			3	SS	28				20.7	
		10		4	SS	7				22.8	
	12.0			5	SS	6				24.8	
Brown and yellowish brown chert and silty clay, very moist to wet, soft.	814.5	15		6	SS	7				29.0	
		20		7	SS	1					
Test boring discontinued at 28.0 feet at auger refusal.	28.0	25									
	798.5	30									
		35									
		40									

SAMPLER TYPE
 SS - DRIVEN SPLIT SPOON
 ST - PRESSED SHELBY TUBE
 CA - CONTINUOUS FLIGHT AUGER
 RC - ROCK CORE

GROUND WATER DEPTH
 ▽ AT COMPLETION 14.0 FT.
 ▽ AFTER _____ FT.
 WATER ON RODS 14.0 FT.

BORING METHOD
 HSA - HOLLOW STEM AUGERS
 CFA - CONTINUOUS FLIGHT AUGERS
 DC - DRIVING CASING
 RW - ROTARY WASH



Client Hussey Gay Bell Boring # 13
 Architect/Engineer _____ Job # 2022-070
 Project Name New 0.366 MGD WWTP Drawn By RTS
 Project Location Pikeville, Tennessee Approved By RTS

TEST DATA

DRILLING AND SAMPLING INFORMATION

Date Started 1/17/23 Hammer Wt. 140 Auto lbs.
 Date Completed 1/17/23 Hammer Drop 30 in.
 Drill Foreman SOUTH BROS Spoon Sampler O.D. 2 in.
 Inspector _____ Rock Core Dia. _____ in.
 Boring Method HSA Shelby Tube O.D. _____ in.

SOIL CLASSIFICATION	STRATUM DEPTH	DEPTH SCALE	LITH- OLOGY	SAMPLE NO.	SAMPLE TYPE	Standard Penetration Test N. Blows/Ft.	Unconfined Compressive Strength Tons/Ft. ²	Pocket Penetrometer Tons/Ft. ²	Natural Dry Density lbs/cu. ft.	Water Content %	Atterberg Limits LL - Liquid Limit PL - Plastic Limit
Reddish brown sandy silty clay, moist, soft to medium stiff.				1	SS	2				20.6	
		5		2	SS	5				19.1	
				3	SS	9					
Yellowish brown chert and silty clay, very moist to wet, medium stiff to very stiff.	8.0	8		4	SS	18				18.9	
	16.0	15		5	SS	26				42.1	
		20		6	SS	3				41.2	
		25		7	SS	19				30.4	
Yellowish gray and gray sandy silty clay, with thin lenses of fine grained sand, very moist, medium stiff.	27.0	27		8	SS	5				22.6	
	29.0			9	SS	50/0.4'					
Test boring discontinued at 36.0 feet at auger refusal.	36.0	35									
	788.0	40									

SAMPLER TYPE
 SS - DRIVEN SPLIT SPOON
 ST - PRESSED SHELBY TUBE
 CA - CONTINUOUS FLIGHT AUGER
 RC - ROCK CORE

GROUND WATER DEPTH
 ▽ AT COMPLETION 16.0 FT.
 ▽ AFTER _____ FT.
 WATER ON RODS 16.0 FT.

BORING METHOD
 HSA - HOLLOW STEM AUGERS
 CFA - CONTINUOUS FLIGHT AUGERS
 DC - DRIVING CASING
 RW - ROTARY WASH



Client Hussey Gay Bell Boring # 14
 Architect/Engineer _____ Job # 2022-070
 Project Name New 0.366 MGD WWTP Drawn By RTS
 Project Location Pikeville, Tennessee Approved By RTS

TEST DATA

DRILLING AND SAMPLING INFORMATION

Date Started 1/17/23 Hammer Wt. 140 Auto lbs.
 Date Completed 1/17/23 Hammer Drop 30 in.
 Drill Foreman SOUTH BROS Spoon Sampler O.D. 2 in.
 Inspector _____ Rock Core Dia. _____ in.
 Boring Method HSA Shelby Tube O.D. _____ in.

SOIL CLASSIFICATION	STRATUM DEPTH	DEPTH SCALE	LITH- OLOGY	SAMPLE NO.	SAMPLE TYPE	Standard Penetration Test N. Blows/Ft.	Unconfined Compressive Strength Tons/Ft. ²	Pocket Penetrometer Tons/Ft. ²	Natural Dry Density lbs/cu. ft.	Water Content %	Atterberg Limits LL - Liquid Limit PL - Plastic Limit
SURFACE ELEVATION - 823.0											
Brown sandy silty clay, moist, soft.	3.0			1	SS	3				16.7	
Reddish brown sandy silty clay, moist, soft.	5.5	5		2	SS	12				19.5	
Brown cherty silty clay, moist, stiff to very stiff.	9.5			3	SS	22				22.6	
	16.0			4	SS	9				19.2	
Yellowish brown fine grained silty sand, moist, medium dense.	16.0	10		5	SS	10				31.9	
Yellowish brown chert and silty clay, wet, soft to very soft.	20.0			6	SS	2				42.9	
	25.0			7	SS	1				30.1	
Test boring discontinued at 28.0 feet at auger refusal.	28.0										
	30.0										
	35.0										
	40.0										

SAMPLER TYPE
 SS - DRIVEN SPLIT SPOON
 ST - PRESSED SHELBY TUBE
 CA - CONTINUOUS FLIGHT AUGER
 RC - ROCK CORE

GROUND WATER DEPTH
 ▽ AT COMPLETION 16.0 FT.
 ▽ AFTER _____ FT.
 WATER ON RODS 16.0 FT.

BORING METHOD
 HSA - HOLLOW STEM AUGERS
 CFA - CONTINUOUS FLIGHT AUGERS
 DC - DRIVING CASING
 RW - ROTARY WASH



Client Hussey Gay Bell Boring # 15
 Architect/Engineer _____ Job # 2022-070
 Project Name New 0.366 MGD WWTP Drawn By RTS
 Project Location Pikeville, Tennessee Approved By RTS

TEST DATA

DRILLING AND SAMPLING INFORMATION

Date Started 1/17/23 Hammer Wt. 140 Auto lbs.
 Date Completed 1/17/23 Hammer Drop 30 in.
 Drill Foreman SOUTH BROS Spoon Sampler O.D. 2 in.
 Inspector _____ Rock Core Dia. _____ in.
 Boring Method HSA Shelby Tube O.D. _____ in.

SOIL CLASSIFICATION	STRATUM DEPTH	DEPTH SCALE	LITHOLOGY	SAMPLE NO.	SAMPLE TYPE	Standard Penetration Test N. Blows/Ft.	Unconfined Compressive Strength Tons/Ft. ²	Pocket Penetrometer Tons/Ft. ²	Natural Dry Density lbs/cu. ft.	Water Content %	Atterberg Limits LL - Liquid Limit PL - Plastic Limit
Dark brown silty clay to clayey silt, moist, soft.	3.0			1	SS	3				21.4	
Brown sandy silty clay, moist to very moist, medium stiff.	815.5	5		2	SS	4				16.0	
	8.0			3	SS	9				20.5	
	810.5	10		4	SS	24				25.1	
Brown to yellowish brown fine grained silty sand, moist to very, dense grading to very loose.		15		5	SS	3				21.3	
	20.0	20		6	SS	50/0.2'				26.1	
Test boring discontinued at the planned exploration depth of 20.0 feet.	798.5										

SAMPLER TYPE: SS - DRIVEN SPLIT SPOON, ST - PRESSED SHELBY TUBE, CA - CONTINUOUS FLIGHT AUGER, RC - ROCK CORE
 GROUND WATER DEPTH: AT COMPLETION 11.0 FT., AFTER _____ FT., WATER ON RODS 11.0 FT.
 BORING METHOD: HSA - HOLLOW STEM AUGERS, CFA - CONTINUOUS FLIGHT AUGERS, DC - DRIVING CASING, RW - ROTARY WASH



Client Hussey Gay Bell Boring # 16
 Architect/Engineer _____ Job # 2022-070
 Project Name New 0.366 MGD WWTP Drawn By RTS
 Project Location Pikeville, Tennessee Approved By RTS

TEST DATA

DRILLING AND SAMPLING INFORMATION

Date Started 1/17/23 Hammer Wt. 140 Auto lbs.
 Date Completed 1/17/23 Hammer Drop 30 in.
 Drill Foreman SOUTH BROS Spoon Sampler O.D. 2 in.
 Inspector _____ Rock Core Dia. _____ in.
 Boring Method HSA Shelby Tube O.D. _____ in.

SOIL CLASSIFICATION	STRATUM DEPTH	DEPTH SCALE	LITH- OLOGY	SAMPLE NO.	SAMPLE TYPE	Standard Penetration Test N. Blows/Ft.	Unconfined Compressive Strength Tons/Ft. ²	Pocket Penetrometer Tons/Ft. ²	Natural Dry Density lbs/cu. ft.	Water Content %	Atterberg Limits LL - Liquid Limit PL - Plastic Limit
SURFACE ELEVATION - 819.5											
Dark brown sandy silty clay to sandy clayey silt, moist, soft.	3.0			1	SS	2				20.8	
Brown silty clay, with some fine grained sand, very moist, soft.	5.5	5		2	SS	3				21.1	
Reddish brown silty clay, with some fine grained sand, moist, medium stiff.	8.0			3	SS	8				23.1	
Brown to yellowish brown fine grained silty sand, cherty, very moist, very loose.	8.0			4	SS	8				20.2	
	15.0	15		5	SS	3				40.5	
Test boring discontinued at the planned exploration depth of 20.0 feet.	20.0	20		6	SS	50/0.4'					
	799.5										

SAMPLER TYPE
 SS - DRIVEN SPLIT SPOON
 ST - PRESSED SHELBY TUBE
 CA - CONTINUOUS FLIGHT AUGER
 RC - ROCK CORE

GROUND WATER DEPTH
 ▽ AT COMPLETION 12.0 FT.
 ▽ AFTER _____ FT.
 WATER ON RODS 12.0 FT.

BORING METHOD
 HSA - HOLLOW STEM AUGERS
 CFA - CONTINUOUS FLIGHT AUGERS
 DC - DRIVING CASING
 RW - ROTARY WASH



Client Hussey Gay Bell Boring # 17
 Architect/Engineer _____ Job # 2022-070
 Project Name New 0.366 MGD WWTP Drawn By RTS
 Project Location Pikeville, Tennessee Approved By RTS

TEST DATA

DRILLING AND SAMPLING INFORMATION

Date Started 1/17/23 Hammer Wt. 140 Auto lbs.
 Date Completed 1/17/23 Hammer Drop 30 in.
 Drill Foreman SOUTH BROS Spoon Sampler O.D. 2 in.
 Inspector _____ Rock Core Dia. _____ in.
 Boring Method HSA Shelby Tube O.D. _____ in.

SOIL CLASSIFICATION	STRATUM DEPTH	DEPTH SCALE	LITH- OLOGY	SAMPLE NO.	SAMPLE TYPE	Standard Penetration Test N. Blows/Ft.	Unconfined Compressive Strength Tons/Ft. ²	Pocket Penetrometer Tons/Ft. ²	Natural Dry Density lbs/cu. ft.	Water Content %	Atterberg Limits LL - Liquid Limit PL - Plastic Limit
Reddish brown silty clay to clayey silt, moist, soft.	3.0			1	SS	3				18.6	
Reddish brown to yellowish red sandy silty clay, moist, medium stiff.	8.0	5		2	SS	7				20.0	
				3	SS	14				18.9	
	8.0	10		4	SS	14				39.9	
Brown cherty silty clay, moist to wet below 13 feet, stiff to very stiff.		15		5	SS	39				49.7	
		20		6	SS	15				45.6	
Test boring discontinued at 23.0 feet at auger refusal.	23.0	25									
	799.0	30									
		35									
		40									

SAMPLER TYPE
 SS - DRIVEN SPLIT SPOON
 ST - PRESSED SHELBY TUBE
 CA - CONTINUOUS FLIGHT AUGER
 RC - ROCK CORE

GROUND WATER DEPTH
 ▽ AT COMPLETION 13.0 FT.
 ▽ AFTER _____ FT.
 WATER ON RODS 13.0 FT.

BORING METHOD
 HSA - HOLLOW STEM AUGERS
 CFA - CONTINUOUS FLIGHT AUGERS
 DC - DRIVING CASING
 RW - ROTARY WASH



Client Hussey Gay Bell Boring # 18
 Architect/Engineer _____ Job # 2022-070
 Project Name New 0.366 MGD WWTP Drawn By RTS
 Project Location Pikeville, Tennessee Approved By RTS

TEST DATA

DRILLING AND SAMPLING INFORMATION

Date Started 1/17/23 Hammer Wt. 140 Auto lbs.
 Date Completed 1/17/23 Hammer Drop 30 in.
 Drill Foreman SOUTH BROS Spoon Sampler O.D. 2 in.
 Inspector _____ Rock Core Dia. _____ in.
 Boring Method HSA Shelby Tube O.D. _____ in.

SOIL CLASSIFICATION	STRATUM DEPTH	DEPTH SCALE	LITH- OLOGY	SAMPLE NO.	SAMPLE TYPE	Standard Penetration Test N. Blows/Ft.	Unconfined Compressive Strength Tons/Ft. ²	Pocket Penetrometer Tons/Ft. ²	Natural Dry Density lbs/cu. ft.	Water Content %	Atterberg Limits LL - Liquid Limit PL - Plastic Limit
SURFACE ELEVATION - 829.0											
Reddish brown silty clay to clayey silt, moist, soft to medium stiff.				1	SS	3				24.2	
	5.5	5		2	SS	6				24.8	
Yellowish red silty clay to clayey silt, with some fine grained sand, moist, medium stiff.	8.0	8		3	SS	9				22.0	
Brown sandy silty clay to sandy clayey silt, with some chert, moist, medium stiff.	10.0	10		4	SS	7				17.5	
Test boring discontinued at the planned exploration depth of 10.0 feet.											
		15									
		20									
		25									
		30									
		35									
		40									

SAMPLER TYPE
 SS - DRIVEN SPLIT SPOON
 ST - PRESSED SHELBY TUBE
 CA - CONTINUOUS FLIGHT AUGER
 RC - ROCK CORE

GROUND WATER DEPTH
 ▽ AT COMPLETION Dry FT.
 ▽ AFTER _____ FT.
 WATER ON RODS _____ FT.

BORING METHOD
 HSA - HOLLOW STEM AUGERS
 CFA - CONTINUOUS FLIGHT AUGERS
 DC - DRIVING CASING
 RW - ROTARY WASH



Client Hussey Gay Bell Boring # 19
 Architect/Engineer _____ Job # 2022-070
 Project Name New 0.366 MGD WWTP Drawn By RTS
 Project Location Pikeville, Tennessee Approved By RTS

TEST DATA

DRILLING AND SAMPLING INFORMATION

Date Started 1/17/23 Hammer Wt. 140 Auto lbs.
 Date Completed 1/17/23 Hammer Drop 30 in.
 Drill Foreman SOUTH BROS Spoon Sampler O.D. 2 in.
 Inspector _____ Rock Core Dia. _____ in.
 Boring Method HSA Shelby Tube O.D. _____ in.

SOIL CLASSIFICATION	STRATUM DEPTH	DEPTH SCALE	LITH- OLOGY	SAMPLE NO.	SAMPLE TYPE	Standard Penetration Test N. Blows/Ft.	Unconfined Compressive Strength Tons/Ft. ²	Pocket Penetrometer Tons/Ft. ²	Natural Dry Density lbs/cu. ft.	Water Content %	Atterberg Limits LL - Liquid Limit PL - Plastic Limit
Dark brown to reddish brown sandy silty clay, moist, medium stiff.	3.0 837.5			1	SS	5				25.9	
Yellowish red and reddish brown silty clay, with trace chert, moist, stiff.	5.5 835.0	5		2	SS	12				35.2	
Yellowish brown cherty silty clay, moist, stiff.	10.0 830.5	10		3	SS	12				39.9	
				4	SS	11				32.0	
Test boring discontinued at the planned exploration depth of 10.0 feet.											

SAMPLER TYPE

- SS - DRIVEN SPLIT SPOON
- ST - PRESSED SHELBY TUBE
- CA - CONTINUOUS FLIGHT AUGER
- RC - ROCK CORE

GROUND WATER DEPTH

- ▽ AT COMPLETION Dry FT.
- ▽ AFTER _____ FT.
- WATER ON RODS _____ FT.

BORING METHOD

- HSA - HOLLOW STEM AUGERS
- CFA - CONTINUOUS FLIGHT AUGERS
- DC - DRIVING CASING
- RW - ROTARY WASH



Client Hussey Gay Bell Boring # 20
 Architect/Engineer _____ Job # 2022-070
 Project Name New 0.366 MGD WWTP Drawn By RTS
 Project Location Pikeville, Tennessee Approved By RTS

TEST DATA

DRILLING AND SAMPLING INFORMATION

Date Started 1/17/23 Hammer Wt. 140 Auto lbs.
 Date Completed 1/17/23 Hammer Drop 30 in.
 Drill Foreman SOUTH BROS Spoon Sampler O.D. 2 in.
 Inspector _____ Rock Core Dia. _____ in.
 Boring Method HSA Shelby Tube O.D. _____ in.

SOIL CLASSIFICATION	STRATUM DEPTH	DEPTH SCALE	LITH- OLOGY	SAMPLE NO.	SAMPLE TYPE	Standard Penetration Test N. Blows/Ft.	Unconfined Compressive Strength Tons/Ft. ²	Pocket Penetrometer Tons/Ft. ²	Natural Dry Density lbs/cu. ft.	Water Content %	Atterberg Limits LL - Liquid Limit PL - Plastic Limit
SURFACE ELEVATION - 841.0											
Reddish brown silty clay to clayey silt, with trace fine grained sand and chert, moist, medium stiff.	3.0	838.0	[Hatched]	1	SS	5				24.9	
Light yellowish red and reddish brown very cherty silty clay, moist, very stiff.	5	838.0	[Hatched]	2	SS	19				16.2	
				3	SS	15				27.7	
				4	SS	17				14.6	
Test boring discontinued at the planned exploration depth of 10.0 feet.	10.0	831.0									
		15									
		20									
		25									
		30									
		35									
		40									

SAMPLER TYPE: SS - DRIVEN SPLIT SPOON, ST - PRESSED SHELBY TUBE, CA - CONTINUOUS FLIGHT AUGER, RC - ROCK CORE
 GROUND WATER DEPTH: AT COMPLETION Dry FT., AFTER _____ FT., WATER ON RODS _____ FT.
 BORING METHOD: HSA - HOLLOW STEM AUGERS, CFA - CONTINUOUS FLIGHT AUGERS, DC - DRIVING CASING, RW - ROTARY WASH



Client Hussey Gay Bell Boring # 21
 Architect/Engineer _____ Job # 2022-070
 Project Name New 0.366 MGD WWTP Drawn By RTS
 Project Location Pikeville, Tennessee Approved By RTS

TEST DATA

DRILLING AND SAMPLING INFORMATION

Date Started 1/17/23 Hammer Wt. 140 Auto lbs.
 Date Completed 1/17/23 Hammer Drop 30 in.
 Drill Foreman SOUTH BROS Spoon Sampler O.D. 2 in.
 Inspector _____ Rock Core Dia. _____ in.
 Boring Method HSA Shelby Tube O.D. _____ in.

SOIL CLASSIFICATION	STRATUM DEPTH	DEPTH SCALE	LITH- OLOGY	SAMPLE NO.	SAMPLE TYPE	Standard Penetration Test N. Blows/Ft.	Unconfined Compressive Strength Tons/Ft. ²	Pocket Penetrometer Tons/Ft. ²	Natural Dry Density lbs/cu. ft.	Water Content %	Atterberg Limits LL - Liquid Limit PL - Plastic Limit
SURFACE ELEVATION - 817.5											
Dark brown silty clay to clayey silt, with trace fine grained sand, very moist, soft.	3.0			1	SS	3				20.6	
Brown sandy clayey silt, very moist, medium stiff.	5.5	5		2	SS	4				21.9	
Yellowish brown cherty silty clay, moist, stiff.	8.0			3	SS	11				22.7	
Dark yellowish brown fine grained silty sand, moist to very moist, dense.	10.0	10		4	SS	27				16.1	
Test boring discontinued at the planned exploration depth of 10.0 feet.											
		15									
		20									
		25									
		30									
		35									
		40									

SAMPLER TYPE
 SS - DRIVEN SPLIT SPOON
 ST - PRESSED SHELBY TUBE
 CA - CONTINUOUS FLIGHT AUGER
 RC - ROCK CORE

GROUND WATER DEPTH
 ▽ AT COMPLETION Dry FT.
 ▽ AFTER _____ FT.
 WATER ON RODS _____ FT.

BORING METHOD
 HSA - HOLLOW STEM AUGERS
 CFA - CONTINUOUS FLIGHT AUGERS
 DC - DRIVING CASING
 RW - ROTARY WASH

NON COHESIVE SOILS

(Silt, Sand, Gravel and Combinations)

DENSITY

Very Loose	- 5 blows/ft. or less
Loose	- 6 to 10 blows/ft.
Medium Dense	-11 to 30 blows/ft.
Dense	-31 to 50 blows/ft.
Very Dense	-51 blows/ft. or more

PARTICLE SIZE IDENTIFICATION

Boulders	-8 inch diameter or more
Cobbles	-3 to 8 inch diameter
Gravel	-Coarse - 1 to 3 inch Medium - 1/2 to 1 inch Fine - 1/4 to 1/2 inch
Sand	-Coarse - 0.6 mm to 1/4 inch (dia. of pencil lead) Medium - 0.2 mm to 0.6 mm (dia. of broom straw) Fine - 0.05mm to 0.2 mm (dia. of human hair)
Silt	-0.06 mm to 0.002 mm (cannot see particles)

RELATIVE PROPORTIONS

Descriptive Term	Percent
Trace	1 - 10
Little	11 - 20
Some	21 - 35
And	36 - 50

COHESIVE SOILS

(Clay, Silt and Combinations)

CONSISTENCY

Very Soft	- 3 blows/ft. or less
Soft	- 4 to 5 blows/ft.
Medium Stiff	- 6 to 10 blows/ft.
Stiff	-11 to 15 blows/ft.
Very Stiff	-16 to 30 blows/ft.
Hard	-31 blows/ft. or more

PLASTICITY

Degree of Plasticity	Plasticity Index
Low	0 - 7
Medium	8 - 22
High	over 22

Classification on logs are made by visual inspection in general accordance with the Unified Classification System.

Standard Penetration Test - Driving a 2.0 " O. D., 1 3/8" I. D., sampler a distance of 1.0 foot into undisturbed soil with a 140 pound hammer free falling a distance of 30.0 inches. It is customary to drive the spoon 6.0 inches to seat the sampler into undisturbed soil, then perform the test. The number of hammer blows for seating the spoon and making the tests are recorded for each 6.0 inches of penetration on the field drill log (Example 6/4/6). On the report log, the Standard Penetration Test result (N value) is normally presented and consists of the sum of the last penetration counts (i.e. N = 4 + 6 = 10 blows/ft.).

Strata Changes - in the column "Soil Descriptions" on the drill log the horizontal lines represent strata changes. A solid line (-----) represents an actually observed strata change, a dashed line (- - - -) represents an estimated strata change.

Groundwater observations were made at the time indicated. Porosity of soil strata, weather conditions, site topography, etc., may cause changes in the water level readings indicated on the logs.

Important Information about This

Geotechnical-Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

The Geoprofessional Business Association (GBA) has prepared this advisory to help you – assumedly a client representative – interpret and apply this geotechnical-engineering report as effectively as possible. In that way, you can benefit from a lowered exposure to problems associated with subsurface conditions at project sites and development of them that, for decades, have been a principal cause of construction delays, cost overruns, claims, and disputes. If you have questions or want more information about any of the issues discussed herein, contact your GBA-member geotechnical engineer. Active engagement in GBA exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project.

Understand the Geotechnical-Engineering Services Provided for this Report

Geotechnical-engineering services typically include the planning, collection, interpretation, and analysis of exploratory data from widely spaced borings and/or test pits. Field data are combined with results from laboratory tests of soil and rock samples obtained from field exploration (if applicable), observations made during site reconnaissance, and historical information to form one or more models of the expected subsurface conditions beneath the site. Local geology and alterations of the site surface and subsurface by previous and proposed construction are also important considerations. Geotechnical engineers apply their engineering training, experience, and judgment to adapt the requirements of the prospective project to the subsurface model(s). Estimates are made of the subsurface conditions that will likely be exposed during construction as well as the expected performance of foundations and other structures being planned and/or affected by construction activities.

The culmination of these geotechnical-engineering services is typically a geotechnical-engineering report providing the data obtained, a discussion of the subsurface model(s), the engineering and geologic engineering assessments and analyses made, and the recommendations developed to satisfy the given requirements of the project. These reports may be titled investigations, explorations, studies, assessments, or evaluations. Regardless of the title used, the geotechnical-engineering report is an engineering interpretation of the subsurface conditions within the context of the project and does not represent a close examination, systematic inquiry, or thorough investigation of all site and subsurface conditions.

Geotechnical-Engineering Services are Performed for Specific Purposes, Persons, and Projects, and At Specific Times

Geotechnical engineers structure their services to meet the specific needs, goals, and risk management preferences of their clients. A geotechnical-engineering study conducted for a given civil engineer

will not likely meet the needs of a civil-works constructor or even a different civil engineer. Because each geotechnical-engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client.

Likewise, geotechnical-engineering services are performed for a specific project and purpose. For example, it is unlikely that a geotechnical-engineering study for a refrigerated warehouse will be the same as one prepared for a parking garage; and a few borings drilled during a preliminary study to evaluate site feasibility will not be adequate to develop geotechnical design recommendations for the project.

Do not rely on this report if your geotechnical engineer prepared it:

- for a different client;
- for a different project or purpose;
- for a different site (that may or may not include all or a portion of the original site); or
- before important events occurred at the site or adjacent to it; e.g., man-made events like construction or environmental remediation, or natural events like floods, droughts, earthquakes, or groundwater fluctuations.

Note, too, the reliability of a geotechnical-engineering report can be affected by the passage of time, because of factors like changed subsurface conditions; new or modified codes, standards, or regulations; or new techniques or tools. *If you are the least bit uncertain* about the continued reliability of this report, contact your geotechnical engineer before applying the recommendations in it. A minor amount of additional testing or analysis after the passage of time – if any is required at all – could prevent major problems.

Read this Report in Full

Costly problems have occurred because those relying on a geotechnical-engineering report did not read the report in its entirety. Do not rely on an executive summary. Do not read selective elements only. *Read and refer to the report in full.*

You Need to Inform Your Geotechnical Engineer About Change

Your geotechnical engineer considered unique, project-specific factors when developing the scope of study behind this report and developing the confirmation-dependent recommendations the report conveys. Typical changes that could erode the reliability of this report include those that affect:

- the site's size or shape;
- the elevation, configuration, location, orientation, function or weight of the proposed structure and the desired performance criteria;
- the composition of the design team; or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project or site changes – even minor ones – and request an assessment of their impact. *The geotechnical engineer who prepared this report cannot accept*

responsibility or liability for problems that arise because the geotechnical engineer was not informed about developments the engineer otherwise would have considered.

Most of the “Findings” Related in This Report Are Professional Opinions

Before construction begins, geotechnical engineers explore a site’s subsurface using various sampling and testing procedures. *Geotechnical engineers can observe actual subsurface conditions only at those specific locations where sampling and testing is performed.* The data derived from that sampling and testing were reviewed by your geotechnical engineer, who then applied professional judgement to form opinions about subsurface conditions throughout the site. Actual sitewide-subsurface conditions may differ – maybe significantly – from those indicated in this report. Confront that risk by retaining your geotechnical engineer to serve on the design team through project completion to obtain informed guidance quickly, whenever needed.

This Report’s Recommendations Are Confirmation-Dependent

The recommendations included in this report – including any options or alternatives – are confirmation-dependent. In other words, they are not final, because the geotechnical engineer who developed them relied heavily on judgement and opinion to do so. Your geotechnical engineer can finalize the recommendations *only after observing actual subsurface conditions* exposed during construction. If through observation your geotechnical engineer confirms that the conditions assumed to exist actually do exist, the recommendations can be relied upon, assuming no other changes have occurred. *The geotechnical engineer who prepared this report cannot assume responsibility or liability for confirmation-dependent recommendations if you fail to retain that engineer to perform construction observation.*

This Report Could Be Misinterpreted

Other design professionals’ misinterpretation of geotechnical-engineering reports has resulted in costly problems. Confront that risk by having your geotechnical engineer serve as a continuing member of the design team, to:

- confer with other design-team members;
- help develop specifications;
- review pertinent elements of other design professionals’ plans and specifications; and
- be available whenever geotechnical-engineering guidance is needed.

You should also confront the risk of constructors misinterpreting this report. Do so by retaining your geotechnical engineer to participate in prebid and preconstruction conferences and to perform construction-phase observations.

Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can shift unanticipated-subsurface-conditions liability to constructors by limiting the information they provide for bid preparation. To help prevent the costly, contentious problems this practice has caused, include the complete geotechnical-engineering report, along with any attachments or appendices, with your contract documents, *but be certain to note*

conspicuously that you’ve included the material for information purposes only. To avoid misunderstanding, you may also want to note that “informational purposes” means constructors have no right to rely on the interpretations, opinions, conclusions, or recommendations in the report. Be certain that constructors know they may learn about specific project requirements, including options selected from the report, *only* from the design drawings and specifications. Remind constructors that they may perform their own studies if they want to, and *be sure to allow enough time* to permit them to do so. Only then might you be in a position to give constructors the information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions. Conducting prebid and preconstruction conferences can also be valuable in this respect.

Read Responsibility Provisions Closely

Some client representatives, design professionals, and constructors do not realize that geotechnical engineering is far less exact than other engineering disciplines. This happens in part because soil and rock on project sites are typically heterogeneous and not manufactured materials with well-defined engineering properties like steel and concrete. That lack of understanding has nurtured unrealistic expectations that have resulted in disappointments, delays, cost overruns, claims, and disputes. To confront that risk, geotechnical engineers commonly include explanatory provisions in their reports. Sometimes labeled “limitations,” many of these provisions indicate where geotechnical engineers’ responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The personnel, equipment, and techniques used to perform an environmental study – e.g., a “phase-one” or “phase-two” environmental site assessment – differ significantly from those used to perform a geotechnical-engineering study. For that reason, a geotechnical-engineering report does not usually provide environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated subsurface environmental problems have led to project failures.* If you have not obtained your own environmental information about the project site, ask your geotechnical consultant for a recommendation on how to find environmental risk-management guidance.

Obtain Professional Assistance to Deal with Moisture Infiltration and Mold

While your geotechnical engineer may have addressed groundwater, water infiltration, or similar issues in this report, the engineer’s services were not designed, conducted, or intended to prevent migration of moisture – including water vapor – from the soil through building slabs and walls and into the building interior, where it can cause mold growth and material-performance deficiencies. Accordingly, *proper implementation of the geotechnical engineer’s recommendations will not of itself be sufficient to prevent moisture infiltration.* **Confront the risk of moisture infiltration** by including building-envelope or mold specialists on the design team. **Geotechnical engineers are not building-envelope or mold specialists.**



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Appendix B

MR Systems SCADA Scope

Customer: City of Pikeville (TN)
 Project: Pikeville 0.366 MGD Wastewater Treatment Plant
 MR Quote #: Q23-11239, Rev. 1



An  **INFRAMARK** Company

October 13, 2023

Quote Expiration

December 12, 2023

Bill of Materials and Labor

Qty	Tag/Loop	Description
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SCOPE OF WORK:

MR Systems (an Inframark Company) is pleased to offer this proposal to provide a new SCADA system, instrumentation, control panels, fiber optic cabling and services as outlined in this proposal for the Pikeville 0.366 MGD Water Treatment Plant project.

MEETINGS:

- Kick-Off Meeting
- Background Graphics / HMI Meeting
- PLC Control Narrative Meeting (via Teams)

SUBMITTALS:

- Field Instrument Submittal
- Control Panel Submittal
- SCADA Hardware & Software Submittal
- Networking Submittal
- HMI Background Graphics Submittal
- Control Narrative Submittal
- Training Submittal
- Testing Submittal
- Operation & Maintenance Manual and Record Documentation

TESTING:

- Unwitnessed Factory Testing
- Witnessed Factory Testing at MR Systems (Norcross, GA)
- On-Site Startup and Testing

TRAINING:

- One (1) Day of Operator Familiarization Training

SCADA HARDWARE & SOFTWARE:

1	VTScada Dual Server Redundant Bundle 5K Tags Development Runtime Alarm Notification Historian Thin Client - Two (2) SupportPlus Bundle (1 Year Included)
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Customer: City of Pikeville (TN)
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Qty	Tag/Loop	Description
1	WS-1	Office SCADA Workstation No.1 - Dell Precision 3660 Workstation 12 Gen Intel® Core™ i7-12700 (25.0 MB cache, 12 cores, 20 threads, 2.10 GHz to 4.90 GHz Turbo, 65 W) 16GB (2x8GB) DDR4 UDIMM non-ECC Memory NVIDIA® T400, 2 GB GDDR6, 3 mDP to DP adapters C1: M.2 SSD Boot + Optional M.2 SSD 512GB PCIe NVMe Class 40 M.2 SSD 8x DVD+/-RW 9.5mm Optical Disk Drive 3 Years Basic Hardware Warranty Repair: 5x10 HW-Only, 5x10 NBD Onsite Windows 11 Pro Microsoft Office Professional 2021
2		Dell Widescreen Monitor, 27"
1		APC SmartUPS, SMT750
1	WS-2	Lab SCADA Workstation No.2 - Dell Precision 3660 Workstation 12 Gen Intel® Core™ i7-12700 (25.0 MB cache, 12 cores, 20 threads, 2.10 GHz to 4.90 GHz Turbo, 65 W) 16GB (2x8GB) DDR4 UDIMM non-ECC Memory NVIDIA® T400, 2 GB GDDR6, 3 mDP to DP adapters C1: M.2 SSD Boot + Optional M.2 SSD 512GB PCIe NVMe Class 40 M.2 SSD 8x DVD+/-RW 9.5mm Optical Disk Drive 3 Years Basic Hardware Warranty Repair: 5x10 HW-Only, 5x10 NBD Onsite Windows 11 Pro Microsoft Office Professional 2021
2		Dell Widescreen Monitor, 27"
1		APC SmartUPS, SMT750
1		Large Wall-Mount Display, 55" Samsung 55" New QLED 4K Smart TV
1		Cables, Brackets, Etc...
1		Firewall Appliance / Remote Access FortiGate 40F UTM with 3-Years FortiCare & FortiGuard Protection

FIBER OPTIC CABLING:

MR Systems will only supply and perform fiber optic cable termination and testing. Installation of cable shall be by OTHERS.

Fiber Optic Cable On-The-Reel Test - Testing of Fiber After Delivery
 Fiber Optic Cable Post Terminations Test

FROM: Laboratory & Office Building (RTU-1)
 TO: Sludge Handling Facility (RTU-2)

- 900 a. Corning FREEDM One, Riser, 6-fiber, Tight-Buffered, 50um, OM3, Multimode
- 12 b. Corning UniCam High-performance Connector, 50um, OM3

Customer: City of Pikeville (TN)
 Project: Pikeville 0.366 MGD Wastewater Treatment Plant
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Qty	Tag/Loop	Description
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NOTE: Ethernet CAT6 cabling and conduit between panels shall be provided and installed by OTHERS.

CONTROL PANELS:

1	RTU-1	<p>Office/Lab Building PLC-based Remote Telemetry Unit Enclosure: NEMA 12 Painted Steel Enclosure Size: 36" H x 30" W x 12" D Solar Heat Protection: None PLC Manufacturer & Model: Allen-Bradley Micro850 Available I/O: 28 DI, 20 DO, 8 AI, 4 AO Wired I/O: 28 DI, 12 DO, 8 AI, 4 AO Operator Interface Terminal: None Communications: Fiber and Light Managed Switch Primary Power: 120VAC Backup Power: Battery Backup with two (2) 9 AH Batteries Features: AC Power Surge Protector LED Light Fixture (mounts in top of panel) GFI Utility Outlet RTU Door Limit Switch Digital I/O Surge Protection: Indicating Interposing Relays Analog I/O Surge Protection: MR Kamikaze II Analog Surge Protector</p>
1	RTU-2	<p>Sludge Dewatering Electrical Building PLC-based Remote Telemetry Unit Enclosure: NEMA 12 Painted Carbon Steel Enclosure Size: 48" H x 36" W x 12" D Solar Heat Protection: None PLC Manufacturer & Model: Allen-Bradley Micro850 Available I/O: 44 DI, 20 DO, 24 AI, 8 AO Wired I/O: 44 DI, 12 DO, 24 AI, 8 AO Operator Interface Terminal: Industrial PanelPC (connects to VTScada Server) Communications: Fiber and Light Managed Switch Primary Power: 120VAC Backup Power: Battery Backup with two (2) 9 AH Batteries Features: AC Power Surge Protector LED Light Fixture (mounts in top of panel) GFI Utility Outlet RTU Door Limit Switch Digital I/O Surge Protection: Indicating Interposing Relays Analog I/O Surge Protection: MR Kamikaze II Analog Surge Protector</p>

Customer: City of Pikeville (TN)
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Qty	Tag/Loop	Description
<u>FIELD INSTRUMENTS:</u>		
MR Systems will provide the following instruments. All other instruments will be provided Equipment Vendors or the Contractor.		
1	FE-101	Parshall Flume Manufacturer & Model: Tracom, 12" Throat, 36"H Service: Influent Flow Accessories: Instrument Tags: #316 SST, Engraved with Tag and Range Ultrasonic Mounting Hardware Staff Gauge
1	LE/FIT-101	Flow Transmitters - Ultrasonic (Transmitter) Manufacturer & Model: Siemens HydroRanger 200 and XRS-5 Sensor Service: Influent Flow Accessories: Instrument Tags: #316 SST, Engraved with Tag and Range AC Power and Analog Surge Protector; Phoenix Contact Boxtrab Sunshade for Transmitter, Aluminum, Painted White
2		
1		
1		
1	SMP-101	Refrigerated Sampler Manufacturer & Model: Teledyne ISCO 5800 Service: Influent Flow Accessories: Instrument Tags: #316 SST, Engraved with Tag and Range AC Power and Analog Surge Protector; Phoenix Contact Boxtrab
1		
1		
1	FE-601	Parshall Flume Manufacturer & Model: Tracom, 9" Throat, 30"H Service: Effluent Flow Accessories: Instrument Tags: #316 SST, Engraved with Tag and Range Ultrasonic Mounting Hardware Staff Gauge
1		
1	LE/FIT-601	Flow Transmitters - Ultrasonic (Transmitter) Manufacturer & Model: Siemens HydroRanger 200 and XRS-5 Sensor Service: Effluent Flow Accessories: Instrument Tags: #316 SST, Engraved with Tag and Range AC Power and Analog Surge Protector; Phoenix Contact Boxtrab Sunshade for Transmitter, Aluminum, Painted White
2		
1		
1		

Customer: City of Pikeville (TN)
 Project: Pikeville 0.366 MGD Wastewater Treatment Plant
 MR Quote #: Q23-11239, Rev. 1



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Qty	Tag/Loop	Description
1	SMP-601	Refrigerated Sampler Manufacturer & Model: Teledyne ISCO 5800 Service: Effluent Flow Accessories:
1		Instrument Tags: #316 SST, Engraved with Tag and Range
1		AC Power and Analog Surge Protector; Phoenix Contact Boxtrab
1	FE/FIT-701	Electromagnetic Flow Meter Element with Remote Transmitter Manufacturer & Model: Rosemount 8750W Service: Digested Sludge Flow Line Size: 8" Accessories:
2		Instrument Tags: #316 SST, Engraved with Tag and Range
1		AC Power and Analog Surge Protector; Phoenix Contact Boxtrab
1		Aluminum Solar Hood
1	AE/AIT-701	Dissolved Oxygen Analyzer Manufacturer & Model: Hach LDO with sc4500 Service: Aerobic Digester Dissolved Oxygen Accessories:
2		Instrument Tags: #316 SST, Engraved with Tag and Range
1		AC Power and Analog Surge Protector; Phoenix Contact Boxtrab
1		Pole Mount Assembly
1	LIT-701	Submersible Pressure (Hydrostatic) Transducer Manufacturer & Model: Dwyer PBLT2 Series Service: Aerobic Digester Level Accessories:
1		Instrument Tags: #316 SST, Engraved with Tag and Range
1		DC Power and Analog Surge Protector; Phoenix Contact Pipetrab
1	FE/FIT-901	Electromagnetic Flow Meter Element with Remote Transmitter Manufacturer & Model: Rosemount 8750W Service: Clarifier No.1 RAS Flow Line Size: 8" Accessories:
2		Instrument Tags: #316 SST, Engraved with Tag and Range
1		AC Power and Analog Surge Protector; Phoenix Contact Boxtrab
1		Aluminum Solar Hood
1	FE/FIT-902	Electromagnetic Flow Meter Element with Remote Transmitter Manufacturer & Model: Rosemount 8750W Service: Clarifier No.2 RAS Flow Line Size: 8" Accessories:
2		Instrument Tags: #316 SST, Engraved with Tag and Range
1		AC Power and Analog Surge Protector; Phoenix Contact Boxtrab
1		Aluminum Solar Hood

Customer: City of Pikeville (TN)
 Project: Pikeville 0.366 MGD Wastewater Treatment Plant
 MR Quote #: Q23-11239, Rev. 1



An  INFRAMARK Company

October 13, 2023

Quote Expiration

Bill of Materials and Labor

December 12, 2023

Qty	Tag/Loop	Description
1	FE/FIT-903	Electromagnetic Flow Meter Element with Remote Transmitter Manufacturer & Model: Rosemount 8750W Service: RAS Flow Line Size: 8" Accessories:
2		Instrument Tags: #316 SST, Engraved with Tag and Range
1		AC Power and Analog Surge Protector; Phoenix Contact Boxtrab
1		Aluminum Solar Hood
1	FE/FIT-904	Electromagnetic Flow Meter Element with Remote Transmitter Manufacturer & Model: Rosemount 8750W Service: WAS Flow Line Size: 4" Accessories:
2		Instrument Tags: #316 SST, Engraved with Tag and Range
1		AC Power and Analog Surge Protector; Phoenix Contact Boxtrab
1		Aluminum Solar Hood
1	PS-901	Pressure Switch with Diaphragm Seal Manufacturer & Model: Ashcroft B4 Series Service: Clarifier No.1 Pressure Low Accessories:
1		Instrument Tag: #316 SST, Engraved with Tag and Range
1		Ball Valve & Assembly: Included
1		Diaphragm Seal: Included
1	PS-902	Pressure Switch with Diaphragm Seal Manufacturer & Model: Ashcroft B4 Series Service: Clarifier No.2 Pressure Low Accessories:
1		Instrument Tag: #316 SST, Engraved with Tag and Range
1		Ball Valve & Assembly: Included
1		Diaphragm Seal: Included
1	PS-903	Pressure Switch with Diaphragm Seal Manufacturer & Model: Ashcroft B4 Series Service: RAS/WAS Discharge Pressure Low Accessories:
1		Instrument Tag: #316 SST, Engraved with Tag and Range
1		Ball Valve & Assembly: Included
1		Diaphragm Seal: Included

Customer: City of Pikeville (TN)
 Project: Pikeville 0.366 MGD Wastewater Treatment Plant
 MR Quote #: Q23-11239, Rev. 1



An  INFRAMARK Company

October 13, 2023

Quote Expiration

December 12, 2023

Bill of Materials and Labor

Qty	Tag/Loop	Description
-----	----------	-------------

VENDOR SYSTEM INTEGRATION:

MR Systems will provide integration services to the WWTP SCADA System for the following vendor equipment.

- Headworks / Screening (CP-101)
- OVIVO Carrousel (CP-201)
- Clarifiers (CP-301, CP-302)
- Chemical Feed Pumps
- Floating Aerators
- Digester System
- Belt Press (CP-801)
- RAS/WAS (CP-901)

Project Labor

One Lot	Project Engineering, Electrical Design, Mechanical Design, Drafting & Administrative Labor (including Travel & Living expenses) to perform final system design and to prepare Submittals and Record Drawings as required by the Contract Documents.
One Lot	HMI Software Applications Development & Graphics Design Labor (including Travel & Living expenses) as required by the Contract Documents.
One Lot	PLC Control Strategy Design & Programming Labor (including Travel & Living expenses) to be performed as required by the Contract Documents.
One Lot	Field Service (including Travel & Living expenses) to provide installation supervision calibrations, startup, training, etc. as required by the Contract Documents.
N/A	Electrical Installation or Terminations (including Travel & Living expenses) to provide installation of conduit, wire, etc. as required by the Contract Documents.
1 Year	Onsite Comprehensive Warranty (including Travel & Living expenses)
One Lot	Freight

Subtotal of Labor and Materials: \$362,612

State Sales Tax is INCLUDED. Assumed sales tax rate is: 9.75%, Included Sales Tax: \$19,776

Total Project Cost: \$382,388

Customer: City of Pikeville (TN)
 Project: Pikeville 0.366 MGD Wastewater Treatment Plant
 MR Quote #: Q23-11239, Rev. 1



An  INFRAMARK Company

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Qty	Tag/Loop	Description
-----	----------	-------------

General Notes:

- A *** Sales Representation ***
 Mr. Herb Timmerman of Eco-Tech, Inc. in Canton, GA, is our local Sales Representative. Herb may be reached at 770-345-2118 (Office) or 404-909-3543 (Cell).

- B *** Technical Questions ***
 For technical or scope of supply questions contact Sothorn Khel, P.E., of MR Systems. Sothorn may be reached at 678-325-2824 (Office) or 770-519-0597 (Cell).

- C *** Installation of Conduit and Wire ***
 This quotation **DOES NOT INCLUDE** the supply or physical installation of conduit or wire unless specifically noted above.

- D *** Equipment Installation ***
 This quotation **DOES NOT INCLUDE** physical installation of field instruments, pipe, tubing, fittings, isolation valves, instrument stands, instrument mounts, control panels, antennas, masts, wooden poles, or other devices or other equipment unless specifically noted above.

- E *** Wiring Terminations ***
 This quotation **INCLUDES** the termination of field wiring to field instruments, control panels, RTU panels, and/or other devices supplied under this scope of supply. Terminations of wiring to equipment supplied by Others are excluded unless specifically noted above.

- F *** Fiber Optics Cable ***
 This quotation **INCLUDES** the supply of Fiber Optic Cable as specifically identified above. The Contractor shall be responsible for conduit and installation of the Fiber Optic Cable supplied by MR Systems.

- G *** Fiber Optic Cable Termination ***
 This quotation **INCLUDES** the terminations and testing of the fiber optics cable.

- H *** Coaxial Cable Installation ***
 This quotation **DOES NOT INCLUDE** the physical installation of coaxial cable or other related components.

- I *** Installation of Communications Towers or Poles ***
 This quotation **DOES NOT INCLUDE** the supply or physical installation of Communication Towers or Poles.

- J *** Contractor License Information ***
 MR Systems' Tennessee Electrical Contractors License Number is 78626 (Unlimited).

Customer: City of Pikeville (TN)
 Project: Pikeville 0.366 MGD Wastewater Treatment Plant
 MR Quote #: Q23-11239, Rev. 1



An  INFRAMARK Company

October 13, 2023

Quote Expiration

December 12, 2023

Bill of Materials and Labor

Qty	Tag/Loop	Description
K		* This Line Is Intentionally Left Blank *
L		* Terms and Conditions * MR Systems General Terms & Conditions of Sale apply to any order resulting from this quotation. Please refer to the link provided below for a copy of our General Terms and Conditions of Sale. https://www.mrsystems.com/sellersterms/
M.		* Performance & Payment Bonds * If you desire MR Systems to provide Performance and Payment Bonds for this project, please let our local sales representative know and we will provide you with an adder for the cost of these bonds.

Revision Notes:

Rev. 0 First Issue - 2023-09-05 - SK
 Rev. 1 Mods per latest Electrical Drawings and Comments from B.Field - 2023-10-13 - SK

Appendix C

SRF Funding Requirements

ADVERTISEMENT FOR BIDS

Project No. _____

_____ (Owner)

Separate sealed bids for _____ for

_____ will be received by _____

at the office of _____

until _____ o'clock ~~A.M./P.M.~~ **C.S.T.**/E.S.T. _____, 20____, and then at said office publicly opened and read aloud.

The Information for Bidders, Form of Bid, Form of Contract, Plans, Specifications, and Forms of Bid Bond, Performance and Payment Bond, and other contract documents may be examined at the following:

Copies may be obtained at the office of _____ located at _____ upon payment of \$ _____ for each set. Digital copies are \$50 and Physical copies are \$100. Payments for contract documents are non-refundable.

The owner reserves the right to waive any informalities or to reject any or all bids.

Each bidder must deposit with his bid, security in the amount, form and subject to the conditions provided in the Information for Bidders.

All bidders must be licensed General Contractors as required by the Contractor's Licensing Act of 1994 of the General Assembly of the State of Tennessee, and qualified for the type of construction being bid upon.

Attention of bidders is particularly called to the requirements as to conditions of employment to be observed and minimum wage rates to be paid under the contract, Section 3, Segregated Facility, Section 109 and E.O. 11246.

No bidder may withdraw his bid within 60 days after the actual date of the opening thereof.

_____ (Date) _____

INFORMATION FOR BIDDERS

1. Receipt and Opening of Bids

The _____ (herein called the "Owner), invites bids on the form attached hereto, all blanks of which must be appropriately filled in. Bids will be received by the Owner at the office of

_____ until _____ o'clock A.M./P.M.,
C.S.T. E.S.T., _____, 20____, and then at said office publicly opened and read aloud. The envelopes containing the bids must be sealed, addressed to _____ at _____ and designated as bid for _____.

The Owner may consider informal any bid not prepared and submitted in accordance with the provisions hereof and may waive any informalities or reject any and all bids. Any bid may be withdrawn prior to the above scheduled time for the opening of bids or authorized postponement thereof. Any bid received after the time and date specified shall not be considered. No bidder may withdraw a bid within 60 days after the actual date of the opening thereof.

2. Preparation of Bid:

Each bid must be submitted on the prescribed form and accompanied by Certification of Bidder Regarding Equal Employment Opportunity, Acknowledgment Regarding Bidder SAM Registration, Certification of Bidder Regarding Section 3 and Segregated Facilities, and Drug-Free Workplace Affidavit. All blank spaces for bid prices must be filled in, in ink or typewritten, in both words and figures, and the foregoing Certifications must be fully completed and executed when submitted.

Each bid must be submitted in a sealed envelope bearing on the outside the name of the bidder, his/her address, the name of the project for which the bid is submitted, license number, expiration date thereof, and license classification of the contractors applying to bid for the prime contract, and for the electrical, plumbing, heating, ventilation, and air conditioning contracts, and all other information required by State law..

All bidders must be licensed General Contractors as required by the Contractor's Licensing Act of 1994 of the General Assembly of the State of Tennessee, and qualified for the type of construction being bid upon. Each bidder shall write on the outside of the envelope containing its bid: 1) its Contractor's license number; 2) that part of the classification applying to the bid. If this is not done, the bid will not be opened.

3. Subcontracts:

The bidder is specifically advised that any person, for, or other party to whom it is proposed to award a subcontract under this contract:

- a. Must be acceptable to the owner; and
- b. Must submit Certification by Proposed Subcontractor Regarding Equal Employment Opportunity, and Certification of Proposed Subcontractor Regarding Section 3 and Segregated Facilities. Approval of the proposed subcontract award cannot be given by the owner unless and until the proposed subcontractor has submitted the Certifications and/or other evidence showing that it has fully complied with any reporting requirements to which it is or was subject.

Although the bidder is not required to attach such Certifications by proposed subcontractors to his/her bid, the bidder is here advised of this requirement so that appropriate action can be taken to prevent subsequent delay in subcontract awards.

4. Telegraphic Modification:

Any bidder may modify his/her bid by telegraphic communication at any time prior to the scheduled closing time for receipt of bids provided such telegraphic communication is received by the Owner prior to the closing time, and, provided further, the Owner is satisfied that a written confirmation of the telegraphic modification over the signature of the bidder was mailed prior to the closing time. The telegraphic communication should not reveal the bid price but should provide the addition or subtraction or other modification so that the final prices or terms will not be known by the Owner until the sealed bid is opened. If written confirmation is not received within two days from the closing time, no consideration will be given to the telegraphic modification.

5. Method of Bidding:

The Owner invites the following bid(s):

6. Qualification of Bidder:

The Owner may make such investigations as s/he deems necessary to determine the ability of the bidder to perform the work, and the bidder shall furnish to the Owner all such information and data for this purpose as the Owner may request. The Owner reserves the right to reject any bid if the evidence submitted by, or investigation of, such bidder fails to satisfy the owner that such bidder is properly qualified to carry out the obligations of the contract and to complete the work contemplated therein. Conditional bids will not be accepted.

7. Bid Security:

Each bid must be accompanied by cash, certified check of the bidder, or a bid bond prepared on the form of bid bond attached thereto, duly executed by the bidder as principal and having as surety thereon a surety company approved by the Owner, in the amount of 5% of the bid. Such cash, checks or bid bonds will be returned to all except the three lowest bidders within three days after the opening of bids, and the remaining cash, checks or bid bonds will be returned promptly after the Owner and the accepted bidder have executed the contract, or, if no award has been made within 60 days after the date of the opening of bids, upon demand of the bidder at any time thereafter, so long as he/she has not been notified of the acceptance of his/her bid.

8. Liquidated Damages for Failure to Enter into Contract:

The successful bidder, upon his/her failure to refusal to execute and deliver the contract and bonds required within 10 days after she/he has received notice of the acceptance of his/her bid, shall forfeit to the Owner, as liquidated damages for such failure or refusal, the security deposited with his/her bid.

9. Time of Completion and Liquidated Damages:

Bidder must agree to commence work on or before a date to be specified in a written "Notice to Proceed" of the Owner and to fully complete the project within _____ consecutive calendar days thereafter. Bidder must agree also to pay as liquidated damages, the sum of \$_____ for each consecutive calendar day thereafter as hereinafter provided in the Supplemental General Conditions.

10. Condition of Work:

Each bidder must inform him/herself fully of the conditions relating to the construction of the project and the employment of labor thereof. Failure to do so will not relieve a successful bidder of his/her obligation to furnish all material and labor necessary to carry out the provisions of his/her contract. Insofar as possible, the contractor, in carrying out the work, must employ such methods as will not cause any interruption of or interference with the work of any other contractor.

11. Addenda and Interpretations:

No interpretation of the meaning of the plans, specifications or other pre-bid documents will be made to any bidder orally.

Every request for such interpretation should be in writing addressed to

and to be given consideration must be received at least five days prior to the date fixed for the opening of bids. Any and all such interpretations and any supplemental instructions will be in the form of written addenda to the specifications which, if issued, will be mailed by certified mail with return receipt requested or emailed to all prospective bidders (at the respective addresses furnished for such purposes), not later than two days prior to the date fixed for the opening of bids. Failure of any bidder to receive any such addendum or interpretation shall not relieve such bidder from any obligation under his/her bid as submitted. All addenda so issued shall become part of the contract documents.

12. Security for Faithful Performance:

Simultaneously with his/her delivery of the executed contract, the Contractor shall furnish a surety bond or bonds as security for faithful performance of this contract and for the payment of all persons performing labor on the project under this contract and furnishing materials in connection with this contract, as specified in the General Conditions included herein. The surety on such bond or bonds shall be a duly authorized surety company satisfactory to the Owner.

13. Power of Attorney:

Attorneys-in-fact who sign bid bonds or contract bonds must file with each bond a certified and effectively dated copy of their power of attorney.

14. Notice of Special Conditions:

Attention is particularly called to those parts of the contract documents and specifications which deal with the following:

- a. Inspection and testing of materials.
- b. Insurance requirements.
- c. Wage rates.
- d. Stated allowances.

15. Laws and Regulations:

The bidder's attention is directed to the fact that all applicable State laws, municipal ordinances, and the rules and regulations of all authorities having jurisdiction over construction of the project shall apply to the contract throughout, and they will be deemed to be included in the contract the same as though herein written out in full.

16. Method of Award - Lowest Qualified Bidder:

After receiving bids and determining the amount of funds estimated by the OWNER as available to finance the contract, the OWNER will award the contract to the lowest responsible bidder. The lowest responsible bidder will be determined upon the basis of the lowest base bid or lowest base bid combined with alternates (additive or deductive). If the contract is to be awarded based on the lowest base bid with alternates, alternates will be accepted in the numerical order in which they are listed in the Form of Bid.

17. Obligation of Bidder:

At the time of the opening of bids each bidder will be presumed to have inspected the site and to have read and to be thoroughly familiar with the plans and contract documents (including all addenda). The failure or omission of any bidder to examine any form, instrument or document shall in no way relieve any bidder from any obligation in respect of his/her bid.

18. Safety Standards and Accident Prevention: With respect to all work performed under this contract, the Contractor shall:

- a. Comply with the safety standards provisions of applicable laws, building and construction codes and the "Manual of Accident Prevention in Construction" published by the Associated General Contractors of America, the requirements of the Occupational Safety and Health Act of 1970 (Public Law 91-596), and the requirements of Title 29 of the Code of Federal Regulations, Section 1518 as published in the "Federal Register", Volume 36, No. 75, Saturday, April 17, 1971.
- b. Exercise every precaution at all times for the prevention of accidents and the protection of persons (including employees) and property.
- c. Maintain at his/her office or other well known place at the job site, all articles necessary for giving first aid to the injured, and shall make standing arrangements for the immediate removal to a hospital or a doctor's care of persons (including employees), who may be injured on the job site. In no case shall employees be permitted to work at a job site before the employer has made a standing arrangement for removal of injured persons to a hospital or a doctor's care.

BID BOND

KNOW ALL MEN BY THESE PRESENTS, that we, the undersigned, _____

_____ as Principal, and _____

as Surety, are hereby held and firmly bound unto _____

as owner in the penal sum of _____ for the

payment of which, well and truly to be made, we hereby jointly and severally bind ourselves, our heirs, executors, administrators, successors and assigns.

Signed, this _____ day of _____, 20____.

The condition of the above obligation is such that whereas the Principal has submitted to _____ a certain Bid, attached hereto and hereby made a part hereof to enter into a contract in writing for the

NOW, THEREFORE,

- (a) If said Bid shall be rejected, or in the alternate.
- (b) If said Bid shall be accepted and the Principal shall execute and deliver a contract in the Form of Contract attached hereto (properly completed in accordance with said Bid) and shall furnish a bond for his faithful performance of said contract, and for the payment of all persons performing labor or furnishing materials in connection therewith, and shall in all other respects perform the agreement created by the acceptance of said Bid, then this obligation shall be void, otherwise the same shall remain in force and effect, it being expressly understood and agreed that the liability of the Surety for any and all claims hereunder shall, in no event, exceed the penal amount of this obligation as herein stated.

The surety for value received, hereby stipulates and agrees that the obligations of said Surety and its bond shall be in no way impaired or affected by an extension of the time within which the Owner may accept such Bid; and said Surety does hereby waive notice of any such extension.

IN WITNESS WHEREOF, the Principal and the Surety have hereunto set their hand and seals, and such of them as are corporations have caused their corporate seals to be hereto affixed and these presents to be signed by their proper officers, the day and year first set forth above.

_____ (L.S.)

Principal

Surety

By: _____

SEAL

BID FOR UNIT PRICE CONTRACTS

Place _____

Date _____

Project No. _____

Proposal of _____ (hereinafter called "Bidder")¹ a corporation, organized and existing under the laws of the State of _____, partnership, or an individual doing business as _____.

To the _____ (hereinafter called "Owner")

Gentlemen:

The Bidder, in compliance with your invitation for bids for the construction of a

_____,
having examined the plans and specifications with related documents and the site of the proposed work, and being familiar with all of the conditions surrounding the construction of the proposed project including the availability of materials and labor, hereby proposes to furnish all labor, materials, and supplies, and to construct the project in accordance with the contract documents, within the time set forth therein, and at the prices stated below. These prices are to cover all expenses incurred in performing the work required under the contract documents, of which this proposal is a part.

Bidder hereby agrees to commence work under this contract on or before a date to be specified in written "Notice to Proceed" of the Owner and to fully complete the project within _____ consecutive calendar days thereafter as stipulated in the specifications. Bidder further agrees to pay as liquidated damages the sum of \$_____ for each consecutive calendar day thereafter as hereinafter provided in Paragraph 3.c. of the Supplemental General Conditions.

¹ _____
Insert corporation, partnership or individual as applicable.

Bidder acknowledges receipt of the following addendum:

Bidder agrees to perform all the _____ work described in the specifications and shown on the plans, for the following unit prices:

ITEM NO.	EST. QTY.	DESCRIPTION	UNIT PRICE (Each)	Total
1	_____	_____	_____ Dollars & Cents	_____ Dollars & Cents
			(\$_____)	(\$_____)
2	_____	_____	_____ Dollars & Cents	_____ Dollars & Cents
			(\$_____)	(\$_____)
3	_____	_____	_____ Dollars & Cents	_____ Dollars & Cents
			(\$_____)	(\$_____)
			TOTAL OF BID	\$_____

(Amounts are to be shown in both words and figures. In case of discrepancy, the amount shown in words will govern.)

The above unit prices shall include all labor, materials, bailing, shoring, removal, overhead, profit, insurance, etc., to cover the finished work of the several kinds called for.

Bidder understands that the Owner reserves the right to reject any or all bids and to waive any informalities in the bidding.

The bidder agrees that this bid shall be good and may not be withdrawn for a period of 60 days after the scheduled closing time for receiving bids.

Upon receipt of written notice of the acceptance of this bid, bidder will execute the formal contract attached within 10 days and deliver a Surety Bond or Bonds as required by Article 5 of the General Conditions. The bid security attached in the sum of

(\$ _____) is to become the property of the Owner in the event the contract and bond are not executed within the time above set forth, as liquidated damages for the delay and additional expense to the Owner caused thereby.

Respectfully submitted:

By: _____
(Title)

(SEAL - if bid is by a corporation)

BID FOR LUMP SUM CONTRACTS

Place _____

Date _____

Project No. _____

Proposal of _____ (hereinafter called "Bidder") (a

_____ corporation/a partnership/an individual doing

(State)

STRIKE OUT INAPPLICABLE TERMS

business as _____)

To the _____

(hereinafter called "Owner")

Gentlemen:

The Bidder, in compliance with your invitation for bids for the construction of

_____ having examined the plans and specifications with related documents and the site of the proposed work, and being familiar with all of the conditions surrounding the construction of the proposed project including the availability of materials and labor, hereby proposes to furnish all labor, materials, and supplies; and to construct the project in accordance with the Contract Documents, within the time set forth therein, and at the prices stated below. These prices are to cover all expenses incurred in performing the work required under the Contract Documents, of which this proposal is a part.

Bidder hereby agrees to commence work under this contract on or before a date to be specified in written "Notice to Proceed" of the Owner and to fully complete the project within _____ consecutive calendar days thereafter as stipulated in the specifications. Bidder further agrees to pay as liquidated damages, the sum of \$ _____ for each consecutive calendar day thereafter as hereinafter provided in Paragraph 3.c. of the Supplemental General Conditions.

Bidder acknowledges receipt of the following addendum:

BASE PROPOSAL: Bidder agrees to perform all of the _____

_____ work described in the

specifications and shown on the plans for the sum _____

_____ (\$ _____) (Amount shall be

shown in both words and figures. In case of discrepancy, the amount shown in words will govern.)

ALTERNATE PROPOSALS

Alternate No. 1: _____

Deduct the sum of _____ (\$ _____)

Alternate No. 2: _____

Deduct the sum of _____ (\$ _____)

Alternate No. 3: _____

Deduct the sum of _____ (\$ _____)

Alternate No. 4: _____

Deduct the sum of _____ (\$ _____)

UNIT PRICES

For changing quantities of work items from those indicated by the contract drawings upon written instructions from the architect/engineer, the following unit prices shall prevail:

- 1. _____ \$ _____
- 2. _____ \$ _____
- 3. _____ \$ _____

The above unit prices shall include all labor, materials, bailing, shoring, removal, overhead, profit, insurance, etc., to cover the finished work of the several kinds called for. Changes shall be processed in accordance with Article 11.3.1 of the General Conditions.

Bidder understands that the Owner reserves the right to reject any or all bids and to waive any informalities in the bidding.

The bidder agrees that this bid shall be good and may not be withdrawn for a period of 60 calendar days after the scheduled closing time for receiving bids.

Upon receipt of written notice of the acceptance of this bid, the bidder will execute the formal contract attached within 10 days and deliver a Surety Bond or Bonds as required by Article 5 of the General Conditions.

The bid security attached in the sum of _____
(\$_____) is to become the property of the Owner in the event the contract
and bond are not executed within the time above set forth, as liquidated damages for the
delay and additional expense to the Owner caused thereby.

Respectfully submitted:

By: _____

(Signature)

(Title)

(Business Address & Zip Code)

(SEAL - if bid is by a corporation)

CLEARANCE OF LOREC NOTATIONS for P&S APPROVAL

Project Name _____

Contract Number _____

Agency, Date and Notation 1:

Response to Notation 1:

Agency, Date and Notation 2:

Response to Notation 2:

Agency, Date and Notation 3:

Response to Notation 3:

This form must accompany Plans and Specifications sent to ECD.

CLEARANCE OF LOREC NOTATIONS for P&S APPROVAL

Project Name _____

Contract Number _____

Agency, Date and Notation 4:

Response to Notation 4:

Agency, Date and Notation 5:

Response to Notation 5:

Agency, Date and Notation 6:

Response to Notation 6:

This form must accompany Plans and Specifications sent to ECD.

CLEARANCE OF LOREC NOTATIONS for P&S APPROVAL

Project Name _____

Contract Number _____

Agency, Date and Notation 7:

Response to Notation 7:

Agency, Date and Notation 8:

Response to Notation 8:

Agency, Date and Notation 9:

Response to Notation 9:

Signature, Title

Date

This form must accompany Plans and Specifications sent to ECD.

ACKNOWLEDGEMENT REGARDING BIDDER SAM REGISTRATION

Pursuant to 2 CFR Parts 183 and 215 and the requirement of the U.S. Department of Housing and Urban Development (HUD), contractors procured directly by grantees, sub-grantees, and/or sub-recipients of HUD funds, including CDBG are required to have an active registration in the System of Award Management (SAM). This document shall be completed and submitted as part of the bid proposal.

1. By submitting this proposal, the prospective bidder certifies that it has an active registration in SAM that is not set to expire within the next 90 days.
2. By submitting this proposal, the prospective bidder certifies neither it, its principals nor affiliates, is presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from participation in this transaction by any Federal department or agency.
3. The certification in this clause is a material representation of fact upon which reliance was placed when this transaction was entered into. If it is later determined that an erroneous certification was rendered, in addition to other remedies available to the Federal Government, the Department or agency with which this transaction originated may pursue available remedies.
4. Further, the prospective bidder shall provide immediate written notice to the person to which this proposal is submitted if at any time the Participant learns that this certification was erroneous when submitted or has become erroneous by reason of changed circumstances.
5. By submitting this proposal, it is agreed that should the proposed covered transaction be entered into, the prospective bidder will not knowingly enter into any lower-tier covered transaction with a person who is debarred, suspended, declared ineligible, or voluntarily excluded from participation in this covered transaction unless authorized by the agency with which this transaction originated.
6. It is further agreed that by submitting this proposal, the prospective bidder will include Certification of Subcontractor Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion without modification, in all lower-tier covered transactions and in all solicitations for lower-tier covered transactions.

Provide the following information as detailed in the prospective bidder's SAM registration:

Entity Name: _____

Address: _____

City: _____ State: _____ Zip: _____

SAM Entity ID: _____ Expiration Date: _____

Active Exclusions: Yes No

CERTIFICATION OF BIDDER REGARDING EQUAL EMPLOYMENT OPPORTUNITY

This certification is required pursuant to Executive Order 11246 (30 F. R. 12319-25). The implementing rules and regulations provide that any bidder or prospective contractor, or any of their proposed subcontractors, shall state as an initial part of the bid or negotiations of the contract whether it has participated in any previous contract or subcontract subject to the equal opportunity clause; and, if so, whether it has filed all compliance reports due under applicable instructions.

Where the certification indicates that the bidder has not filed a compliance report due under applicable instructions, such bidder shall be required to submit a compliance report within seven calendar days after bid opening. No contract shall be awarded unless such report is submitted.

Certification by Bidder

Bidder/Firm: _____

Address: _____

City: _____ State _____ Zip _____

- | | | | |
|-----------------------------------------------------------------------------------------------------------------------|-----|----|-----------|
| 1. Bidder has participated in a previous contract or subcontract subject to the Equal Opportunity Clause. | Yes | No | |
| 2. Compliance reports were required to be filed in connection with such contract or subcontract. | Yes | No | |
| 3. Bidder has filed all compliance reports due under applicable instructions, including SF-100. | Yes | No | None Req. |
| 4. Have you ever been or are you being considered for sanction due to violation of Executive Order 11246, as amended? | Yes | No | |

Bidder Name: _____

Title: _____

Signature: _____

Date: _____

**CERTIFICATION OF BIDDER REGARDING USE OF
FEMALE/MINORITY SUBCONTRACTORS**

This certification is required for the contractor to demonstrate that when subcontractors are to be used on this project, an attempt will be made to utilize female/minority owned firms.

Documentation must be on file to show who has been contacted.

Certification by Bidder

Bidder/Firm: _____

Address: _____

City: _____ State _____ Zip _____

I, _____, certify that every attempt was made to utilize female/minority contractors on this project.

Bidder Name: _____

Title: _____

Signature: _____

Date: _____

CERTIFICATION OF SUBCONTRACTOR REGARDING DEBARMENT, SUSPENSION, INELIGIBILITY AND EXCLUSION

Pursuant to 2 CFR Parts 183, 215, and 2424, and the requirement of the U.S. Department of Housing and Urban Development (HUD), subcontractors for projects that are funded in whole or in part by HUD funds must provide information concerning the entity’s debarment, suspension, ineligibility or exclusion status. This document shall be completed and provided to the prime contractor.

1. By signing and submitting this proposal, the prospective lower-tier participant certifies that neither it, its principals nor affiliates, is presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from participation in this transaction by any Federal department or agency. Further, the Participant provides the certification set out below:

2. The certification in this clause is a material representation of fact upon which reliance was placed when this transaction was entered into. If it is later determined that an erroneous certification was rendered, in addition to other remedies available to the Federal Government, the Department or agency with which this transaction originated may pursue available remedies.

3. Further, the Participant shall provide immediate written notice to the person to which this proposal is submitted if at any time the Participant learns that this certification was erroneous when submitted or has become erroneously by reason of changed circumstances.

4. By submitting this document, it is agreed that should the proposed covered transaction be entered into, the Participant will not knowingly enter into any lower-tier covered transaction with a person who is debarred, suspended, declared ineligible, or voluntarily excluded from participation in this covered transaction unless authorized by the agency with which this transaction originated.

The subcontracting entity may satisfy the requirement of this document via one of the two options below:

Option 1: SAM.gov Active Registration

Entity Name: _____

Address: _____

City: _____ State: _____ Zip: _____

SAM Entity ID: _____ Expiration Date: _____

Active Exclusions: Yes No

Option 2: Signed Certification

Entity Name: _____

Address: _____

City: _____ State: _____ Zip: _____

Entity Representative: _____ Title: _____

Signature: _____

CERTIFICATION OF BIDDER REGARDING SECTION 3 AND SEGREGATED FACILITIES

NAME OF PRIME CONTRACTOR: _____

PROJECT NUMBER: _____

The undersigned hereby certifies that

- Section 3 provisions are included in the Contract.
- If contract equals or exceeds \$200,000, the contractor will comply with all Section 3 requirements detailed in the CDBG Manual, including:
 - reporting total labor hours worked,
 - reporting total labor hours worked by Section 3 workers,
 - reporting total labor hours worked by Targeted Section 3 workers,
 - Providing documentation of Section 3 worker status as required for all workers for the project under the covered contract.
- No segregated facilities will be maintained as required by Title VI of the Civil Rights Act of 1964.

Name & Title of Signer (Print or Type)

Signature

Date

DRUG-FREE WORKPLACE AFFIDAVIT

STATE OF _____

COUNTY OF _____

The undersigned, principal officer of _____, an employer of five (5) or more employees contracting with _____ government to provide construction services, hereby states under oath as follows:

1. The undersigned is a principal officer of _____ (hereinafter referred to as the "Company"), and is duly authorized to execute this Affidavit on behalf of the Company.
2. The Company submits this Affidavit pursuant to T.C.A. § 50-9-113, which requires each employer with no less than five (5) employees receiving pay who contracts with the state or any local government to provide construction services to submit an affidavit stating that such employer has a drug-free workplace program that complies with Title 50, Chapter 9, of the Tennessee Code Annotated.
3. The Company is in compliance with T.C.A. § 50-9-113.

Further affiant saith not.

Principal Officer

STATE OF _____

COUNTY OF _____

Before me personally appeared _____, with whom I am personally acquainted (or proved to me on the basis of satisfactory evidence), and who acknowledged that such person executed the foregoing affidavit for the purposes therein contained.

Witness my hand and seal at office this _____ day of _____, 20____.

Notary Public

My commission expires: _____

**CERTIFICATION BY PROPOSED SUBCONTRACTOR
REGARDING EQUAL EMPLOYMENT OPPORTUNITY**

NAME OF PRIME CONTRACTOR: _____

PROJECT NUMBER: _____

This certification is required pursuant to Executive Order 11246 (30 F. R. 12319-25). The implementing rules and regulations provide that any bidder or prospective contractor, or any of their proposed subcontractors, shall state as an initial part of the bid or negotiations of the contract whether it has participated in any previous contract or subcontract subject to the equal opportunity clause; and, if so, whether it has filed all compliance reports due under applicable instructions.

Where the certification indicates that the subcontractor has not filed a compliance report due under applicable instructions, such subcontractor shall be required to submit a compliance report before the owner approves the subcontract or permits work to begin under the subcontract.

SUBCONTRACTOR'S CERTIFICATION

Subcontractor Name: _____

Address: _____

City: _____ State _____ Zip _____

- | | | | |
|-----------------------------------------------------------------------------------------------------------------------|-----|----|-----------|
| 1. Bidder has participated in a previous contract or subcontract subject to the Equal Opportunity Clause. | Yes | No | |
| 2. Compliance reports were required to be filed in connection with such contract or subcontract. | Yes | No | |
| 3. Bidder has filed all compliance reports due under applicable instructions, including SF-100. | Yes | No | None Req. |
| 4. Have you ever been or are you being considered for sanction due to violation of Executive Order 11246, as amended? | Yes | No | |

Name: _____

Title: _____

Signature: _____

Date: _____

CERTIFICATION OF PROPOSED SUBCONTRACTOR REGARDING SECTION 3 AND SEGREGATED FACILITIES

NAME OF SUBCONTRACTOR: _____

PROJECT NUMBER: _____

The undersigned hereby certifies that

- Section 3 provisions are included in the Contract.
- If contract equals or exceeds \$200,000, the contractor will comply with all Section 3 requirements detailed in the CDBG Manual, including:
 - reporting total labor hours worked,
 - reporting total labor hours worked by Section 3 workers,
 - reporting total labor hours worked by Targeted Section 3 workers,
 - Providing documentation of Section 3 worker status as required for all workers for the project under the covered contract.
- No segregated facilities will be maintained as required by Title VI of the Civil Rights Act of 1964.
-

Name & Title of Signer (Print or Type)

Signature

Date

**STATEMENT OF COMPLIANCE CERTIFICATE
ILLEGAL IMMIGRANT**

EACH CONTRACTOR BIDDING SHALL FILL IN AND SIGN THE FOLLOWING

Bidder Name: _____

Address: _____

City: _____ State _____ Zip _____

This is to certify that _____ have fully complied with all the requirements of T.C.A. § 12-3-309, stating:

- (1) No state governmental entity shall contract to acquire goods or services from any person who knowingly utilizes the services of illegal immigrants in the performance of a contract for goods or services entered into with a state governmental entity;
- (2) No person may contract to supply goods or services to a state governmental entity if that person knowingly utilizes the services of illegal immigrants in the performance of a contract to supply goods or services entered into with the state or a state entity.

All Bidders for construction services on this project shall be required to submit an affidavit (by executing this compliance document) as part of their bid, that attests that such Bidder shall comply with requirements of T.C.A. § 12-3-309.

Name: _____

Title: _____

Signature: _____

Date: _____

CERTIFICATION OF NON-BOYCOTT OF ISRAEL

The Bidder certifies that it is not currently engaged in, and will not for the duration of the contract engage in, a boycott of Israel as defined by Tenn. Code Ann. § 12-4-119. This provision shall not apply to contracts with a total value of less than two hundred fifty thousand dollars (\$250,000) or to contractors with less than ten (10) employees.

According to the law, a boycott of Israel means engaging in refusals to deal, terminating business activities, or other commercial actions that are intended to limit commercial relations with Israel, or companies doing business in or with Israel or authorized by, licensed by, or organized under the laws of the State of Israel to do business, or persons or entities doing business in Israel, when such actions are taken:

- 1) In compliance with, or adherence to, calls for a boycott of Israel, or
- 2) In a manner that discriminates on the basis of nationality, national origin, religion, or other unreasonable basis, and is not based on a valid business reason. Tenn. Code Ann. § 12-4-119.

I certify this statement to be true and correct.

Bidder Name Printed

Date

Signature of Bidder

Company

**IRAN DIVESTMENT
ACT**

In compliance with the Iran Divestment Act (State of Tennessee 2016, Public Chapter No. 817), which became effective on July 1, 2016, certification is required of all bidders on contracts over \$1,000.

By submission of this bid, each bidder and each person signing on behalf of any bidder certifies, and in the case of a joint bid each party hereto certifies as to its own organization, under penalty of perjury, that to the best of its knowledge and belief that each bidder is not on the list created pursuant to T.C.A. § 12-12-106.

I affirm, under the penalties of perjury, this statement to be true and correct.

Date	Signature of Bidder
	Company

A bid shall not be considered for award nor shall award be made where the foregoing certification has been complied with; provided, however, that if in any case the bidder cannot make the foregoing certification, the bidder shall so state and shall furnish with the bid a signed statement which sets forth in detail the reasons therefor. The **City/County of _____** may award a bid to a bidder who cannot make the certification, on case-by-case basis, if:

1. The investment activities in Iran were made before July 1, 2016, the investment activities in Iran have not been expanded or reviewed on or after July 1, 2016, and the person has adopted, publicized, and is implementing a formal plan to cease the investment activities in Iran and to refrain from engaging in any new investments in Iran; or
2. The **City/County of _____** makes a determination that the goods or services are necessary for the **City/County of _____** to perform its functions and that, absent such an exemption, the political subdivision will be unable to obtain the goods or services for which the contract is offered. Such determination shall be made in writing and shall be a public document.



Department of
General Services

Central
Procurement Office

NOTICE

Tenn. Code Ann. § 12-12-106 requires the chief procurement officer to publish, using credible information freely available to the public, a list of persons it determines engage in investment activities in Iran, as described in § 12-12-105.

For these purposes, the State intends to use the attached list of “Entities determined to be non-responsive bidders/offerers pursuant to the New York State Iran Divestment Act of 2012.”

While inclusion on this list would make a person ineligible to contract with the state of Tennessee, if a person ceases its engagement in investment activities in Iran, it may be removed from the list.

If you feel as though you have been erroneously included on this list please contact the Central Procurement Office at CPO.Website@tn.gov.

Tennessee Tower, 3rd Floor • 312 Rosa L. Parks Avenue • Nashville, TN 37243
615-741-1035 • Fax: 615-741-0684 • tn.gov/generalservices

List Date: May 4, 2022

Source: <https://www.ogs.ny.gov/iran-divestment-act-2012>

1. Ak Makina, Ltd.
2. Amona
3. Bank Markazi Iran (Central Bank of Iran)
4. Bank Mellat
5. Bank Melli Iran
6. Bank Saderat Iran
7. Bank Sepah
8. Bank Tejarat
9. China Precision Machinery Import- Export Corporation (CPMIEC)
10. ChinaOil (China National United Oil Corporation)
11. China National Offshore Oil Corporation (CNOOC)
12. China National Petroleum Corporation (CNPC)
13. Indian Oil Corporation
14. Kingdream PLC
15. Naftiran Intertrade Co. (NICO)
16. National Iranian Tanker Co. (NITC)
17. Oil and Natural Gas Corporation (ONGC)
18. Oil India, Ltd.
19. Persia International Bank
20. Petroleos de Venezuela (PDVSA Petróleo, SA)
21. PetroChina Co., Ltd.
22. Petronet LNG, Ltd.
23. Sameh Afzar Tajak Co. (SATCO)
24. Shandong FIN CNC Machine Co., Ltd.
25. Sinohydro Co., Ltd.
26. Sinopec Corp. (China Petroleum & Chemical Corporation)
27. SKS Ventures
28. SK Energy Co., Ltd.
29. Som Petrol AS
30. Unipec (China International United Petroleum & Chemicals Co., Ltd.)
31. Zhuhai Zhenrong Co.

WAGE RATE DETERMINATION

Appropriate Wage Rates shall be inserted here.

AGREEMENT

THIS AGREEMENT, made this _____ day of _____, 20____, by and between _____, herein called "Owner", acting herein through its _____, and _____,

STRIKE OUT (a corporation) (a partnership)
INAPPLICABLE (an individual doing business as _____)
TERMS

of _____, County of _____, and State of _____, hereinafter called "Contractor".

WITNESSETH: That for and in consideration of the payments and agreements hereinafter mentioned, to be made and performed by the OWNER, the CONTRACTOR hereby agrees with the OWNER to commence and complete the construction described as follows:

hereinafter called "the project", for the sum of _____

_____ Dollars (\$ _____) and all extra work in connection therewith, under the terms as stated in the General and Special Conditions of the Contract; and at this (its or their) own property cost and expense to furnish all the materials , supplies, machinery, equipment, tools, superintendence, labor, insurance, and other accessories and services necessary to complete the said project in accordance with the conditions and prices stated in the Proposal, the General Conditions, Supplemental General Conditions and Special Conditions of the Contract, the plans, which include all maps, plats, blue prints, and other drawings and printed or written explanatory matter thereof, the specifications and contract documents therefore as prepared by _____, herein entitled "the Architect/Engineer", and as enumerated in Paragraph 1 of the Supplemental General Conditions, all of which are made a part hereof and collectively evidence and constitute the contract.

The Contractor hereby agrees to commence work under this contract on or before a date to be specified in a written "Notice to Proceed" of the Owner and to fully complete the project within _____ consecutive calendar days thereafter. The Contractor further agrees to pay, as liquidated damages, the sum of \$ _____ for each consecutive calendar day thereafter as hereinafter provided in Paragraph 3 of the Supplemental General Conditions.

The OWNER agrees to pay the CONTRACTOR in current funds for the performance of the contract, subject to additions and deductions, as provided in the General Conditions of the Contract, and to make payments on account thereof as provided in Paragraph 3, "Payments to Contractor", of the Supplemental General Conditions.

IN WITNESS WHEREOF, the parties to these presents have executed this contract in six (6) counterparts, each of which shall be deemed an original, in the year and day first above mentioned.

ATTEST: _____
(Seal) (Owner)

(Secretary)

By: _____

(Witness)

(Title)

(Seal)

(Contractor)

(Secretary)

By: _____

(Witness)

(Title)

(Address, City, State, and Zip Code)

BONDING AND INSURANCE

1. This Attachment sets forth bonding and insurance requirements for grants. No other bonding and insurance requirements shall be imposed other than those normally required by the grantee.
2. Except as otherwise required by law, a grant that requires the contracting (or subcontracting) for construction or facility improvements shall provide for the grantee to follow its own requirements relating to bid guarantees, performance bonds, and payment bonds unless the construction contract or subcontract exceeds \$150,000 (See 2 CFR 200.88). For those contracts or subcontracts exceeding \$150,000, the Federal agency may accept the bonding policy and requirements of the grantee provided the Federal agency has made a determination that the Government's interest is adequately protected. If such a determination has not been made, the minimum requirements shall be as follows:
 - a. A bid guarantee from each bidder equivalent to five percent of the bid price. The "bid guarantee" shall consist of a firm commitment such as a bid bond, certified check, or other negotiable instrument accompanying a bid as assurance that the bidder will, upon acceptance of his bid, execute such contractual documents as may be required within the time specified.
 - b. A performance bond on the part of the contractor for 100 percent of the contract price. A "performance bond" is one executed in connection with a contract to secure fulfillment of all the contractor's obligations under such contract.
 - c. A payment bond on the part of the contractor for 100 percent of the contract price. A "payment bond" is one executed in connection with a contract to assure payment as required by law of all persons supplying labor and material in the execution of the work provided for in the contract.
3. Where the Federal Government guarantees or insures the repayment of money borrowed by the grantee, the Federal agency, at its discretion, may require adequate bonding and insurance if the bonding and insurance requirements of the grantee are not deemed adequate to protect the interest of the Federal Government.
4. Where bonds are required in the situations described above, the bonds shall be obtained from companies holding certificates of authority as acceptable sureties (31 CFR 223).

NOTE: AIA Document A311 is acceptable for use as Performance and Payment Bonds.

CERTIFICATE OF OWNER'S ATTORNEY

I, the undersigned, _____, the duly authorized and acting legal representative of _____ do hereby certify as follows:

I have examined the attached contract(s) and surety bonds and the manner of execution thereof, and I am of the opinion that each of the aforesaid agreements has been duly executed by the proper parties thereto acting through their duly authorized representatives; that said representatives have full power and authority to execute said agreements on behalf of the respective parties named thereon; and that the foregoing agreements constitute valid and legally binding obligations upon the parties executing the same in accordance with terms, conditions and provisions thereof.

Date: _____

<p>Certification of Compliance with Minimum Standards for Accessibility by the Physically Handicapped</p>

Contract No. _____

Project Name: _____

Address: _____

Pursuant to the requirements of the Architectural Barriers Act of 1968, 42 USC 4151, and the regulations issued subsequent thereto, the undersigned certifies that the design of the above-mentioned project is in conformance with the minimum standards contained in the American Standard Specifications for Making Buildings and Facilities Accessible To and Usable by the Physically Handicapped, Number A-117.1R-1971 (as modified by 41 CFR 101-19.603).

Professional Registrant for the Project: _____

Legal Name and Address: _____

Registration Number: _____

Name: _____



(Signature)

Date: _____

Local Government Official: _____

(Signature)

Status of Land Acquisition

All permanent easements, land purchases, city/county/state right of ways, Department of Transportation, Corps of Engineers and railroad permits and any other land access agreements must be obtained and recorded (if applicable) with the appropriate agencies prior to ECD approval of plans and specifications.

Please check the following boxes and sign below:

Yes No N/A

All permanent easements necessary for the construction of this project have been acquired and recorded with the appropriate agency.

All land acquisition necessary for the construction of this project has been acquired and recorded with the appropriate agency.

All right-of-ways, permits, and land access agreements necessary for the construction of this project have been acquired and recorded with the appropriate agency(s).

OR

The construction of this project requires no acquisition of land, permanent easements, right-of-ways, permits or land access agreements.



Signature of grantee, engineer/architect,
or project administrator

07/17/2023

Date

**This form must be sent to ECD before we
can approve plans and specifications.**

Community Development Block Grant Program GENERAL CONDITIONS

1. Contract and Contract Documents

The project to be constructed and pursuant to this contract will be financed with assistance from the Tennessee Community Development Block Grant Program and is subject to all applicable Federal laws and regulations.

The Plans, Specifications and Addenda, hereinafter enumerated in Paragraph 1 of the Supplemental General Conditions shall form part of this Contract and the provisions thereof shall be as binding upon the parties hereto as if they were herein fully set forth. The table of contents, titles, headings, running headlines and marginal notes contained herein and in said documents are solely to facilitate reference to various provisions of the Contract Documents and in no way affect, limit or cast light on the interpretation of the provisions to which they refer.

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GENERAL CONDITIONS

ARTICLE 1--DEFINITIONS

Wherever used in these General Conditions or in the other Contract

Documents the following terms have the meanings indicated which are applicable to both the singular and plural thereof:

1.1. *Addenda*--Written or graphic instruments issued prior to the opening of Bids which clarify, correct or change the Bidding Requirements or the Contract Documents.

1.2. *Agreement*--The written contract between OWNER and CONTRACTOR covering the Work to be performed; other Contract Documents are attached to the Agreement and made a part thereof as provided therein.

1.3. *Application for Payment*--The form accepted by ENGINEER which is to be used by CONTRACTOR in requesting progress or final payments and which is to be accompanied by such supporting documentation as is required by the Contract Documents.

1.4. *Asbestos*--Any material that contains more than one percent asbestos and is friable or is releasing asbestos fibers into the air above current action levels established by the United States Occupational Safety and Health Administration.

1.5. *Bid*--The offer or proposal of the bidder submitted on the prescribed form setting forth the prices for the Work to be performed.

1.6. *Bidding Documents*--The advertisement or invitation to Bid, instructions to bidders, the Bid form, and the proposed Contract Documents (including all Addenda issued prior to receipt of Bids).

1.7. *Bidding Requirements*--The advertisement or invitation to Bid, instructions to bidders, and the Bid form.

1.8. *Bonds*--Performance and Payment bonds and other instruments of security.

1.9. *Change Order*--A document recommended by ENGINEER, which is signed by CONTRACTOR and OWNER and authorizes an addition, deletion or revision in the Work, or an adjustment in the Contract Price or the Contract Times, issued on or after the Effective Date of the Agreement.

1.10. *Contract Documents*--The Agreement, Addenda (which pertain to the Contract Documents), CONTRACTOR's Bid (including documentation accompanying the Bid and any post Bid documentation submitted prior to the Notice of Award) when attached as an exhibit to the Agreement, the Notice to Proceed, the Bonds, these General Conditions, the Supplementary Conditions, the Specifications and the Drawings as the same are more specifically identified in the Agreement, together with all Written Amendments, Change Orders, Work Change Directives, Field Orders and ENGINEER's written interpretations and classifications issued pursuant to paragraphs 3.5, 3.6.1, and 3.6.3 on or after the Effective Date of the Agreement. Shop Drawing submittals approved pursuant to paragraphs 6.26 and 6.27 and the reports and drawings referred to in paragraphs 4.2.1.1 and 4.2.2.2 are not Contract Documents.

1.11. *Contract Price*--The moneys payable by OWNER to CONTRACTOR for completion of the Work in accordance with the Contract Documents as stated in the Agreement (subject to the provisions of paragraph 11.9.1 in the case of Unit Price Work).

1.12. *Contract Times*--The numbers of days or the dates stated in the Agreement: (i) to achieve Substantial Completion, and (ii) to complete the Work so that it is ready for final payment as evidenced by ENGINEER's written recommendation of final payment in accordance with paragraph 14.13.

1.13. *CONTRACTOR*--The person, firm or corporation with whom the OWNER has entered into the Agreement.

1.14. *defective*--An adjective which when modifying the word Work refers to Work that is unsatisfactory, faulty or deficient, in that it does not conform to the Contract Documents, or does not meet the requirements of any inspection, reference standard, test or approval referred to in the Contract Documents, or has been damaged prior to ENGINEER's recommendation of final payment (unless responsibility for the protection thereof has been assumed by OWNER at Substantial Completion in accordance with paragraph 14.8 or 14.10).

1.15. *Drawings*--The drawings which show the scope, extent and character of the Work to be furnished and performed by CONTRACTOR and which have been prepared or approved by ENGINEER and are referred to in the Contract Documents. Shop drawings are not Drawings as so defined.

1.16. *Effective Date of the Agreement*--The date indicated in the Agreement on which it becomes effective, but if no such date is indicated it means the date on which the Agreement is signed and delivered by the last of the two parties to sign and deliver.

1.17. *ENGINEER*--The person, firm or corporation named as such in the Agreement.

1.18. *ENGINEER's Consultant*--A person, firm, or corporation having a contract with ENGINEER to furnish services as ENGINEER's independent professional associate or consultant with respect to the Project and who is identified as such in the Supplementary Conditions.

1.19. *Field Order*--A written order issued by ENGINEER which orders minor changes in the Work in accordance with paragraph 9.5 but which does not involve a change in the Contract Price or the Contract Times.

1.20. *General Requirements*--Sections of Division 1 of the Specifications.

1.21. *Hazardous Waste*--The term Hazardous Waste shall have the meaning provided in Section 1004 of the Solid Waste Disposal Act (42 USC Section 6903) as amended from time to time.

1.22. *Laws and Regulations: Laws or Regulations*--Any and all applicable laws, rules, regulations, ordinances, codes and orders of any and all governmental bodies, agencies, authorities and courts having jurisdiction.

1.23. *Liens*--Liens, charges, security interests or encumbrances upon real property or personal property.

1.24. *Milestone*--A principal event specified in the Contract Documents relating to an intermediate completion date or time prior to Substantial Completion of all the Work.

1.25. *Notice of Award*--The written notice by OWNER to the apparent successful bidder stating that upon compliance by the apparent successful bidder with the conditions precedent enumerated therein, within the time specified, OWNER will sign and deliver the Agreement.

1.26. *Notice to Proceed*--A written notice given by OWNER to CONTRACTOR (with a copy to ENGINEER) fixing the date on which the Contract Times will commence to run and on which CONTRACTOR shall start to perform CONTRACTOR's obligations under the Contract Documents.

1.27. *OWNER*--The public body or authority, corporation, association, firm or person with whom CONTRACTOR has entered into the Agreement and for whom the Work is to be provided.

1.28. *Partial Utilization*--Use by OWNER of a substantially completed part of the Work for the purpose for which it is intended (or a related purpose) prior to Substantial Completion of all the Work.

1.29. *PCBs*--Polychlorinated biphenyls.

1.30. *Petroleum*--Petroleum, including crude oil or any fraction thereof which is liquid at standard conditions of temperature and pressure (60 degrees Fahrenheit and 14.7 pounds per square inch absolute), such as oil, petroleum, fuel oil, oil sludge, oil refuse, gasoline, kerosene, and oil mixed with other non-Hazardous Wastes and crude oils.

1.31. *Project*--The total construction of which the Work to be provided under the Contract Documents may be the whole, or a part as indicated elsewhere in the Contract Documents.

1.32. *Radioactive Material*--Source, special nuclear, or byproduct material as defined by the Atomic Energy Act of 1954 (42 USC Section 2011 et seq.) as amended from time to time.

1.33. *Resident Project Representative*--The authorized representative of ENGINEER who may be assigned to the site or any part thereof.

1.34. *Samples*--Physical examples of materials, equipment, or workmanship that are representative of some portion of the Work and which establish the standards by which such portion of the Work will be judged.

1.35. *Shop Drawings*--All drawings, diagrams, illustrations, schedules and other data or information which are specifically prepared or assembled by or for CONTRACTOR and submitted by CONTRACTOR to illustrate some portion of the Work.

1.36. *Specifications*--Those portions of the Contract Documents consisting of written technical descriptions of materials, equipment, construction systems, standards and workmanship as applied to the Work and certain administrative details applicable thereto.

1.37. *Subcontractor*--An individual, firm or corporation having a direct contract with CONTRACTOR or with any other Subcontractor for the performance of a part of the Work at the site.

1.38. *Substantial Completion*--The Work (or a specified part thereof) has progressed to the point where, in the opinion of ENGINEER as evidenced by ENGINEER's definitive certificate of Substantial Completion, it is sufficiently complete, in accordance with the Contract Documents, so that the Work (or specified part) can be utilized for the purposes for which it is intended; or if no such certificate is issued, when the Work is complete and ready for final payment as evidenced by ENGINEER's written recommendation of final payment in accordance with paragraph 14.13. The terms "substantially complete" and "substantially completed" as applied to all or part of the Work refer to Substantial Completion thereof.

1.39. *Supplementary Conditions*--The part of the Contract Documents which amends or supplements these General Conditions.

1.40. *Supplier*--A manufacturer, fabricator, supplier, distributor, materialman or vendor having a direct contract with CONTRACTOR or with any Subcontractor to furnish materials or equipment to be incorporated in the Work by CONTRACTOR or any Subcontractor.

1.41. *Underground Facilities*--All pipelines, conduits, ducts, cables, wires, manholes, vaults, tanks, tunnels or other such facilities or attachments, and any encasements containing such facilities which have been installed underground to furnish any of the following services or materials: electricity, gases, steam, liquid petroleum products, telephone or other communications, cable television, sewage and drainage removal, traffic or other control systems or water.

1.42. *Unit Price Work*--Work to be paid for on the basis of unit prices.

1.43. *Work*--The entire completed construction or the various separately identifiable parts thereof required to be furnished under the Contract Documents. Work includes and is the result of performing or furnishing labor and furnishing and incorporating materials and equipment into the construction, and performing or furnishing services and furnishing documents, all as required by the Contract Documents.

1.44. *Work Change Directive*--A written directive to CONTRACTOR, issued on or after the Effective Date of the Agreement and signed by OWNER and recommended by ENGINEER, ordering an addition, deletion or revision in the Work, or responding to differing or unforeseen physical conditions under which the Work is to be performed as provided in paragraph 4.2 or 4.3 or to emergencies under paragraph 6.23. A Work Change Directive will not change the Contract Price or the Contract Times, but is evidence that the parties expect that the change directed or documented by a Work Change Directive will be incorporated in a subsequently issued Change Order following negotiations by the parties as to its effect, if any, on the Contract Price or Contract Times as provided in paragraph 10.2.

1.45. *Written Amendment*--A written amendment of the Contract Documents, signed by OWNER and CONTRACTOR on or after the Effective Date of the Agreement and normally dealing with the nonengineering or nontechnical rather than strictly construction-related aspects of the Contract Documents.

ARTICLE 2--PRELIMINARY MATTERS

Delivery of Bonds:

2.1. When CONTRACTOR delivers the executed Agreements to OWNER, CONTRACTOR shall also deliver to OWNER such Bonds

as CONTRACTOR may be required to furnish in accordance with paragraph 5.1.

Copies of Documents:

2.2. OWNER shall furnish to CONTRACTOR up to ten copies (unless otherwise specified in the Supplementary Conditions) of the Contract Documents as are reasonably necessary for the execution of the Work. Additional copies will be furnished, upon request, at the cost of reproduction.

Commencement of Contract Times; Notice to Proceed:

2.3. The Contract Times will commence to run on the thirtieth day after the Effective Date of the Agreement, or, if a Notice to Proceed is given, on the day indicated in the Notice to Proceed. A Notice to Proceed may be given at any time within thirty days after the Effective Date of the Agreement. In no event will the Contract Times commence to run later than the sixtieth day after the day of Bid opening or the thirtieth day after the Effective Date of the Agreement, whichever date is earlier.

Starting the Work:

2.4. CONTRACTOR shall start to perform the Work on the date when the Contract Times commence to run, but no Work shall be done at the site prior to the date on which the Contract Times commence to run.

Before Starting Construction:

2.5. Before undertaking each part of the Work, CONTRACTOR shall carefully study and compare the Contract Documents and check and verify pertinent figures shown thereon and all applicable field measurements. CONTRACTOR shall promptly report in writing to ENGINEER any conflict, error, ambiguity or discrepancy which CONTRACTOR may discover and shall obtain a written interpretation or clarification from ENGINEER before proceeding with any Work affected thereby; however, CONTRACTOR shall not be liable to OWNER or ENGINEER for failure to report any conflict, error, ambiguity or discrepancy in the Contract Documents, unless CONTRACTOR knew or reasonably should have known thereof.

2.6. Within ten days after the Effective Date of the Agreement (unless otherwise specified in the General Requirements), CONTRACTOR shall submit to ENGINEER for review:

2.6.1. a preliminary progress schedule indicating the times (numbers of days or dates) for starting and completing the various stages of the Work, including any Milestones specified in the Contract Documents;

2.6.2. a preliminary schedule for Shop Drawing and Sample submittals which will list each required submittal and the times for submitting, reviewing and processing such submittal;

2.6.3. a preliminary schedule of values for all of the Work which will include quantities and prices of items aggregating the Contract Price and will subdivide the Work into component parts in sufficient detail to serve as the basis for progress payments during construction. Such prices will include an appropriate amount of overhead and profit applicable to each item of Work.

2.7. Before any Work at the site is started, CONTRACTOR and OWNER shall each deliver to the other, with copies to each additional insured identified in the Supplementary Conditions, certificates of insurance (and other evidence of insurance which either of them or any additional insured may reasonably request) which CONTRACTOR and OWNER respectively are required to purchase and maintain in accordance with paragraphs 5.4, 5.6 and 5.7.

Preconstruction Conference:

2.8. Within twenty days after the Contract Times start to run, but before any Work at the site is started, a conference attended by CONTRACTOR, ENGINEER and others as appropriate will be held to establish a working understanding among the parties as to the Work and to discuss the schedules referred to in paragraph 2.6, procedures for handling Shop Drawings and other submittals, processing Applications for Payment and maintaining required records.

Initially Acceptable Schedules:

2.9. Unless otherwise provided in the Contract Documents, at least ten days before submission of the first Application for Payment a conference attended by CONTRACTOR, ENGINEER and others as appropriate will be held to review for acceptability to ENGINEER as provided below the schedules submitted in accordance with paragraph 2.6. CONTRACTOR shall have an additional ten days to make corrections and adjustments and to complete and resubmit the schedules. No progress payment shall be made to CONTRACTOR until the schedules are submitted to and acceptable to ENGINEER as provided below. The progress schedule will be acceptable to ENGINEER as providing an orderly progression of the Work to completion within any specified Milestones and the Contract Times, but such acceptance will neither impose on ENGINEER responsibility for the sequencing, scheduling or progress of the Work nor interfere with or relieve CONTRACTOR from CONTRACTOR's full responsibility therefore. CONTRACTOR's schedule of Shop Drawing and Sample submissions will be acceptable to ENGINEER as providing a workable arrangement for reviewing and processing the required submittals. CONTRACTOR's schedule of values will be acceptable to ENGINEER as to form and substance.

ARTICLE 3--CONTRACT DOCUMENT: INTENT,
AMENDING, REUSE

Intent:

3.1. The Contract Documents comprise the entire agreement between OWNER and CONTRACTOR concerning the Work. The Contract Documents are complementary; what is called for by one is as binding as if called for by all. The Contract Documents will be construed in accordance with the law of the place of the Project.

3.2. It is the intent of the Contract Documents to describe a functionally complete Project (or part thereof) to be constructed in accordance with the Contract Documents. Any Work, materials or equipment that may reasonably be inferred from the Contract Documents or from prevailing custom or trade usage as being required to produce the intended result will be furnished and performed whether or not specifically called for. When words or phrases which have a well-known technical or construction industry or trade meaning are used to describe Work, materials or equipment, such words or phrases shall be interpreted in accordance with that meaning. Clarifications and interpretations of the Contract Documents shall be issued by ENGINEER as provided in paragraph 9.4.

3.3. Reference to Standards and Specifications of Technical Societies; Reporting and Resolving Discrepancies:

3.3.1. Reference to standards, specifications, manuals or codes of any technical society, organization or association, or to the Laws or Regulations of any governmental authority, whether such reference be specific or by implication, shall mean the latest standard, specification, manual, code or Laws or Regulations in effect at the time of opening of Bids (or, on the Effective Date of the Agreement if there were no Bids), except as may be otherwise specifically stated in the Contract Documents.

3.3.2. If, during the performance of the Work, CONTRACTOR discovers any conflict, error, ambiguity or discrepancy within the Contract Documents or between the Contract Documents and any provision of any such Law or Regulation applicable to the performance of the Work or of any such standard, specification, manual or code or of any instruction of any Supplier referred to in paragraph 6.5, CONTRACTOR shall report it to ENGINEER in writing at once, and, CONTRACTOR shall not proceed with the Work affected thereby (except in an emergency as authorized by paragraph 6.23) until an amendment or supplement to the Contract Documents has been issued by one of the methods indicated in paragraph 3.5 or 3.6; provided, however, that CONTRACTOR shall not be liable to OWNER or ENGINEER for failure to report any such conflict, error, ambiguity or discrepancy unless CONTRACTOR knew or reasonably should have known thereof.

3.3.3. Except as otherwise specifically stated in the Contract Documents or as may be provided by amendment or supplement thereto issued by one of the methods indicated in paragraph 3.5 or 3.6, the provisions of the Contract Documents shall take precedence in resolving any conflict, error, ambiguity or discrepancy between the provisions of the Contract Documents and:

3.3.3.1. the provisions of any such standard, specification, manual, code or instruction (whether or not specifically incorporated by reference in the Contract Documents); or

3.3.3.2. the provisions of any such Laws or Regulations applicable to the performance of the Work (unless such an interpretation of the provisions of the Contract Documents would result in violation of such Law or Regulation).

No provision of any such standard, specification, manual, code or instruction shall be effective to change the duties and responsibilities of OWNER, CONTRACTOR or ENGINEER, or any of their subcontractors, consultants, agents, or employees from those set forth in the Contract Documents, nor shall it be effective to assign to OWNER, ENGINEER or any of ENGINEER's Consultants, agents or employees any duty or authority to supervise or direct the furnishing or performance of the Work or any duty or authority to undertake responsibility inconsistent with the provisions of paragraph 9.13 or any other provision of the Contract Documents.

3.4. Whenever in the Contract Documents the terms "as ordered," "as directed," "as required," "as allowed," "as approved" or terms of like effect or import are used, or the adjectives "reasonable," "suitable," "acceptable," "proper" or "satisfactory" or adjectives of like effect or import are used to describe a requirement, direction, review or judgment of ENGINEER as to the Work, it is intended that such requirement, direction, review or judgment will be solely to evaluate, in general, the completed Work for compliance with the requirements of and information in the Contract Documents and conformance with the

design concept of the completed Project as a functioning whole as shown or indicated in the Contract Documents (unless there is a specific statement indicating otherwise). The use of any such term or adjective shall not be effective to assign to ENGINEER any duty or authority to supervise or direct the furnishing or performance of the Work or any duty or authority to undertake responsibility contrary to the provisions of paragraph 9.13 or any other provision of the Contract Documents.

Amending and Supplementing Contract Documents:

3.5. The Contract Documents may be amended to provide for additions, deletions and revisions in the Work or to modify the terms and conditions thereof in one or more of the following ways:

3.5.1. a formal Written Amendment.

3.5.2. a Change Order (pursuant to paragraph 10.4), or

3.5.3. a Work Change Directive (pursuant to paragraph 10.1).

3.6. In addition, the requirements of the Contract Documents may be supplemented, and minor variations and deviations in the Work may be authorized, in one or more of the following ways:

3.6.1. a Field Order (pursuant to paragraph 9.5),

3.6.2. ENGINEER's approval of a Shop Drawing or Sample (pursuant to paragraphs 6.26 and 6.27), or

3.6.3. ENGINEER's written interpretation or clarification (pursuant to paragraph 9.4).

Reuse of Documents:

3.7. CONTRACTOR, and any Subcontractor or Supplier or other person or organization performing or furnishing any of the Work under a direct or indirect contract with OWNER (i) shall not have or acquire any title to or ownership rights in any of the Drawings, Specifications or other documents (or copies of any thereof) prepared by or bearing the seal of ENGINEER or ENGINEER's Consultant, and (ii) shall not reuse any of such Drawings, Specifications, other documents or copies on extensions of the Project or any other project without written consent of OWNER and ENGINEER and specific written verification or adaption by ENGINEER.

ARTICLE 4--AVAILABILITY OF LANDS; SUBSURFACE AND PHYSICAL CONDITIONS; REFERENCE POINTS

Availability of Lands:

4.1. OWNER shall furnish, as indicated in the Contract Documents, the lands upon which the Work is to be performed, rights-of-way and easements for access thereto, and such other lands which are designated for the use of CONTRACTOR. Upon reasonable written request, OWNER shall furnish CONTRACTOR with a correct statement of record legal title and legal description of the lands upon which the Work is to be performed and OWNER's interest therein as necessary for giving notice of or filing a mechanic's lien against such lands in accordance with applicable Laws and Regulations. OWNER shall identify any encumbrances or restrictions not of general application but

specifically related to use of lands so furnished with which CONTRACTOR will have to comply in performing the Work. Easements for permanent structures or permanent changes in existing facilities will be obtained and paid for by OWNER, unless otherwise provided in the Contract Documents. If CONTRACTOR and OWNER are unable to agree on entitlement to or the amount or extent of any adjustments in the Contract Price or the Contract Times as a result of any delay in OWNER's furnishing these lands, rights-of-way or easements, CONTRACTOR may make a claim therefore as provided in Articles 11 and 12. CONTRACTOR shall provide for all additional lands and access thereto that may be required for temporary construction facilities or storage of materials and equipment.

4.2. *Subsurface and Physical Conditions:*

4.2.1. *Reports and Drawings:* Reference is made to the Supplementary Conditions for identification of:

4.2.1.1. *Subsurface Conditions:* Those reports of explorations and tests of subsurface conditions at or contiguous to the site that have been utilized by ENGINEER in preparing the Contract Documents; and

4.2.1.2. *Physical Conditions:* Those drawings of physical conditions in or relating to existing surface or subsurface structures at or contiguous to the site (except Underground Facilities) that have been utilized by ENGINEER in preparing the Contract Documents.

4.2.2. *Limited Reliance by CONTRACTOR Authorized: Technical Data:* CONTRACTOR may rely upon the general accuracy of the "technical data" contained in such reports and drawings, but such reports and drawings are not Contract Documents. Such "technical data" is identified in the Supplementary Conditions. Except for such reliance on such "technical data," CONTRACTOR may not rely upon or make any claim against OWNER, ENGINEER or any of ENGINEER's Consultants with respect to:

4.2.2.1. the completeness of such reports and drawings for CONTRACTOR's purposes, including, but not limited to, any aspects of the means, methods, techniques, sequences and procedures of construction to be employed by CONTRACTOR and safety precautions and programs incident thereto, or

4.2.2.2. other data, interpretations, opinions and information contained in such reports or shown or indicated in such drawings, or

4.2.2.3. any CONTRACTOR interpretation of or conclusion drawn from any "technical data" or any such data, interpretations, opinions or information.

4.2.3. *Notice of Differing Subsurface or Physical Conditions:* If CONTRACTOR believes that any subsurface or physical condition at or contiguous to the site that is uncovered or revealed either:

4.2.3.1. is of such a nature as to establish that any "technical data" on which CONTRACTOR is entitled to rely as provided in paragraphs 4.2.1 and 4.2.2 is materially inaccurate, or

4.2.3.2. is of such a nature as to require a change in the Contract Documents, or

4.2.3.3. differs materially from that shown or indicated in the Contract Documents, or

4.2.3.4. is of an unusual nature, and differs materially from conditions ordinarily encountered and generally recognized as inherent in work of the character provided for in the Contract Documents; then

CONTRACTOR shall, promptly after becoming aware thereof and before further disturbing conditions affected thereby or performing any Work in connection therewith (except in an emergency as permitted by paragraph 6.23), notify OWNER and ENGINEER in writing about such condition. CONTRACTOR shall not further disturb such conditions or perform any Work in connection therewith (except as aforesaid) until receipt of written order to do so.

4.2.4. *ENGINEER's Review:* ENGINEER will promptly review the pertinent conditions, determine the necessity of OWNER's obtaining additional exploration or tests with respect thereto and advise OWNER in writing (with a copy to CONTRACTOR) of ENGINEER's findings and conclusions.

4.2.5. *Possible Contract Documents Change:* If ENGINEER concludes that a change in the Contract Documents is required as a result of a condition that meets one or more of the categories in paragraph 4.2.3., a Work Change Directive or a Change Order will be issued as provided in Article 10 to reflect and document the consequences of such change.

4.2.6. *Possible Price and Times Adjustments:* An equitable adjustment in the Contract Price or in the Contract Times, or both, will be allowed to the extent that the existence of such uncovered or revealed condition causes an increase or decrease in CONTRACTOR's cost of, or time required for performance of, the Work; subject, however, to the following:

4.2.6.1. such condition must meet any one or more of the categories described in paragraphs 4.2.3.1 through 4.2.3.4, inclusive;

4.2.6.2. a change in the Contract Documents pursuant to paragraph 4.2.5 will not be an automatic authorization of nor a condition precedent to entitlement to any such adjustment;

4.2.6.3. with respect to Work that is paid for on a Unit Price Basis, any adjustment in Contract Price will be subject to the provisions of paragraphs 9.10 and 11.9; and

4.2.6.4. CONTRACTOR shall not be entitled to any adjustment in the Contract Price or Times if;

4.2.6.4.1. CONTRACTOR knew of the existence of such conditions at the time CONTRACTOR made a final commitment to OWNER in respect of Contract Price and Contract Times by the submission of a bid or becoming bound under a negotiated contract; or

4.2.6.4.2. the existence of such condition could reasonably have been discovered or revealed as a result of any examination, investigation, exploration, test or study of the site and contiguous areas required by the Bidding Requirements or Contract Documents to be conducted by or for CONTRACTOR prior to CONTRACTOR's making such final commitment; or

4.2.6.4.3. CONTRACTOR failed to give the written notice within the time and as required by paragraph 4.2.3.

If OWNER and CONTRACTOR are unable to agree on entitlement to or as to the amount or length of any such equitable adjustment in the Contract Price or Contract Times, a claim may be made therefore as provided in Articles 11 and 12. However, OWNER, ENGINEER and ENGINEER's Consultants shall not be liable to CONTRACTOR for any claims, costs, losses or damages sustained by CONTRACTOR on or in connection with any other project or anticipated project.

4.3. Physical Conditions--Underground Facilities:

4.3.1. *Shown or Indicated:* The information and data shown or indicated in the Contract Documents with respect to existing Underground Facilities at or contiguous to the site is based on information and data furnished to OWNER or ENGINEER by the owners of such Underground Facilities or by others. Unless it is otherwise expressly provided in the Supplementary Conditions:

4.3.1.1. OWNER and ENGINEER shall not be responsible for the accuracy or completeness of any such information or data; and

4.3.1.2. The cost of all of the following will be included in the Contract Price and CONTRACTOR shall have full responsibility for: (i) reviewing and checking all such information and data, (ii) locating all Underground Facilities shown or indicated in the Contract Documents, (iii) coordination of the Work with the owners of such Underground Facilities during construction, and (iv) the safety and protection of all such Underground Facilities as provided in paragraph 6.20 and repairing any damage thereto resulting from the Work.

4.3.2. *Not Shown or Indicated:* If an Underground Facility is uncovered or revealed at or contiguous to the site which was not shown or indicated in the Contract Documents, CONTRACTOR shall, promptly after becoming aware thereof and before further disturbing conditions affected thereby or performing any Work in connection therewith (except in an emergency as required by paragraph 6.23), identify the owner of such Underground Facility and give written notice to that owner and to OWNER and ENGINEER. ENGINEER will promptly review the Underground Facility and determine the extent, if any, to which a change is required in the Contract Documents to reflect and document the consequences of the existence of the Underground Facility. If ENGINEER concludes that a change in the Contract Documents is required, a Work Change Directive or a Change Order will be issued as provided in Article 10 to reflect and document such consequences. During such time, CONTRACTOR shall be responsible for the safety and protection of such Underground Facility as provided in paragraph 6.20. CONTRACTOR shall be allowed an increase in the Contract Price or an extension of the Contract Times, or both, to the extent that they are attributable to the existence of any Underground Facility that was not shown or indicated in the Contract Documents and that CONTRACTOR did not know of and could not reasonably have been expected to be aware of or to have anticipated. If OWNER and CONTRACTOR are unable to agree on entitlement to or the amount or length of any such adjustment in Contract Price or Contract Times, CONTRACTOR may make a claim therefore as provided in Articles 11 and 12. However, OWNER, ENGINEER and ENGINEER's Consultants shall not be liable to CONTRACTOR for any claims, costs, losses or damages incurred or sustained by CONTRACTOR on or in connection with any other project or anticipated project.

Reference Points:

4.4. OWNER shall provide engineering surveys to establish reference points for construction which in ENGINEER's judgment are necessary to enable CONTRACTOR to proceed with the Work. CONTRACTOR shall be responsible for laying out the Work, shall protect and preserve the established reference points and shall make no changes or relocations without the prior written approval of OWNER. CONTRACTOR shall report to ENGINEER whenever any reference point is lost or destroyed or requires relocation because of necessary changes in grades or locations, and shall be responsible for the accurate replacement or relocation of such reference points by professionally qualified personnel.

4.5. Asbestos, PCBs, Petroleum, Hazardous Waste or Radioactive Material:

4.5.1. OWNER shall be responsible for any Asbestos, PCBs, Petroleum, Hazardous Waste or Radioactive Material uncovered or revealed at the site which was not shown or indicated in Drawings or Specifications or identified in the Contract Documents to be within the scope of the Work and which may present a substantial danger to persons or property exposed thereto in connection with the Work at the site. OWNER shall not be responsible for any such materials brought to the site by CONTRACTOR, Subcontractor, Suppliers or anyone else for whom CONTRACTOR is responsible.

4.5.2. CONTRACTOR shall immediately: (i) stop all Work in connection with such hazardous condition and in any area affected thereby (except in an emergency as required by paragraph 6.23), and (ii) notify OWNER and ENGINEER (and thereafter confirm such notice in writing). OWNER shall promptly consult with ENGINEER concerning the necessity for OWNER to retain a qualified expert to evaluate such hazardous condition or take corrective action, if any. CONTRACTOR shall not be required to resume Work in connection with such hazardous condition or in any such affected area until after OWNER has obtained any required permits related thereto and delivered to CONTRACTOR special written notice: (i) specifying that such condition and any affected area is or has been rendered safe for the resumption of Work, or (ii) specifying any special conditions under which such Work may be resumed safely. If OWNER and CONTRACTOR cannot agree as to entitlement to or the amount or extent of an adjustment, if any, in Contract Price or Contract Times as a result of such Work stoppage or such special conditions under which Work is agreed by CONTRACTOR to be resumed, either party may make a claim therefore as provided in Articles 11 and 12.

4.5.3. If after receipt of such special written notice CONTRACTOR does not agree to resume such Work based on a reasonable belief it is unsafe, or does not agree to resume such Work under such special conditions, then OWNER may order such portion of the Work that is in connection with such hazardous condition or in such affected area to be deleted from the Work. If OWNER and CONTRACTOR cannot agree as to entitlement to or the amount or extent of an adjustment, if any, in Contract Price or Contract Times as a result of deleting such portion of the Work, then either party may make a claim therefore as provided in Articles 11 and 12. OWNER may have such deleted portion of the Work performed by OWNER's own forces or others in accordance with Article 7.

4.5.4. To the fullest extent permitted by Laws and Regulations, OWNER shall indemnify and hold harmless CONTRACTOR, Subcontractors, ENGINEER, ENGINEER's Consultants and the officers, directors, employees, agents, other consultants and subcontractors of each and any of them from and against all

claims, costs, losses and damages arising out of or resulting from such hazardous condition, provided that: (i) any such claim, cost, loss or damage is attributable to bodily injury, sickness, disease or death, or to injury to or destruction of tangible property (other than the Work itself), including the loss of use resulting there from, and (ii) nothing in this subparagraph 4.5.4 shall obligate OWNER to indemnify any person or entity from and against the consequences of that person's or entity's own negligence.

4.5.5. The provisions of paragraphs 4.2 and 4.3 are not intended to apply to Asbestos, PCBs, Petroleum, Hazardous Waste or Radioactive Material uncovered or revealed at the site.

ARTICLE 5--BONDS AND INSURANCE

Performance, Payment and Other Bonds:

5.1. CONTRACTOR shall furnish Performance and Payment Bonds, each in an amount at least equal to the Contract Price as security for the faithful performance and payment of all CONTRACTOR's obligations under the Contract Documents. These Bonds shall remain in effect at least until one year after the date when final payment becomes due, except as provided otherwise by Laws or Regulations or by the Contract Documents. CONTRACTOR shall also furnish such other Bonds as are required by the Supplementary Conditions. All Bonds shall be in the form prescribed by the Contract Documents except as provided otherwise by Laws or Regulations, and shall be executed by such sureties as are named in the current list of "Companies Holding Certificates of Authority as Acceptable Sureties on Federal Bonds and as Acceptable Reinsuring Companies" as published in Circular 570 (amended) by the Audit Staff, Bureau of Government Financial Operations, U.S. Treasury Department. All Bonds signed by an agent must be accompanied by a certified copy of such agent's authority to act.

5.2. If the surety on any Bond furnished by CONTRACTOR is declared a bankrupt or becomes insolvent or its right to do business is terminated in any state where any part of the Project is located or it ceases to meet the requirements of paragraph 5.1, CONTRACTOR shall within ten days thereafter substitute another Bond and surety, both of which must be acceptable to OWNER.

5.3. Licensed Sureties and Insurers; Certificates of Insurance:

5.3.1. All Bonds and insurance required by the Contract Documents to be purchased and maintained by OWNER or CONTRACTOR shall be obtained from surety or insurance companies that are duly licensed or authorized in the jurisdiction in which the Project is located to issue Bonds or insurance policies for the limits and coverages so required. Such surety and insurance companies shall also meet such additional requirements and qualifications as may be provided in the Supplementary Conditions.

5.3.2. CONTRACTOR shall deliver to OWNER, with copies to each additional insured identified in the Supplementary Conditions, certificates of insurance (and other evidence of insurance requested by OWNER or any other additional insured) which CONTRACTOR is required to purchase and maintain in accordance with paragraph 5.4. OWNER shall deliver to CONTRACTOR, with copies to each additional insured identified in the Supplementary Conditions, certificates of insurance (and other evidence of insurance requested by CONTRACTOR or any other additional insured) which OWNER is

required to purchase and maintain in accordance with paragraphs 5.6 and 5.7 hereof.

CONTRACTOR's Liability Insurance:

5.4. CONTRACTOR shall purchase and maintain such liability and other insurance as is appropriate for the Work being performed and furnished and as will provide protection from claims set forth below which may arise out of or result from CONTRACTOR's performance and furnishing of the Work and CONTRACTOR's other obligations under the Contract Documents, whether it is to be performed or furnished by CONTRACTOR, any Subcontractor or Supplier, or by anyone directly or indirectly employed by any of them to perform or furnish any of the Work, or by anyone for whose acts any of them may be liable:

5.4.1. claims under workers' compensation, disability benefits and other similar employee benefit acts;

5.4.2. claims for damages because of bodily injury, occupational sickness or disease, or death of CONTRACTOR's employees;

5.4.3. claims for damages because of bodily injury, sickness or disease, or death of any person other than CONTRACTOR's employees;

5.4.4. claims for damages insured by customary personal injury liability coverage which are sustained: (i) by any person as a result of an offense directly or indirectly related to the employment of such person by CONTRACTOR, or (ii) by any other person for any other reason;

5.4.5. claims for damages, other than to the Work itself, because of injury to or destruction of tangible property wherever located, including loss of use resulting there from; and

5.4.6. claims for damages because of bodily injury or death of any person or property damage arising out of the ownership, maintenance or use of any motor vehicle.

The policies of insurance so required by this paragraph 5.4 to be purchased and maintained shall:

5.4.7. with respect to insurance required by paragraphs 5.4.3. through 5.4.6 inclusive, include as additional insured (subject to any customary exclusion in respect of professional liability) OWNER, ENGINEER, ENGINEER's Consultants and any other persons or entities identified in the Supplementary Conditions, all of whom shall be listed as additional insured, and include coverage for the respective officers and employees of all such additional insured;

5.4.8. include the specific coverages and be written for not less than the limits of liability provided in the Supplementary Conditions or required by Laws or Regulations, whichever is greater;

5.4.9. include completed operations insurance;

5.4.10. include contractual liability insurance covering CONTRACTOR's indemnity obligations under paragraphs 6.12, 6.16 and 6.31 through 6.33;

5.4.11. contain a provision or endorsement that the coverage afforded will not be cancelled, materially changed or renewal refused until at least thirty days prior written notice has been given to OWNER and CONTRACTOR and to each other additional insured identified in the Supplementary Conditions to whom a certificate of insurance has been issued (and the certificates of insurance furnished by the CONTRACTOR pursuant to paragraph 5.3.2 will so provide);

5.4.12. remain in effect at least until final payment and at all times thereafter when CONTRACTOR may be correcting, removing or replacing *defective* Work in accordance with paragraph 13.12; and

5.4.13. with respect to completed operations insurance, and any insurance coverage written on a claims-made basis, remain in effect for at least two years after final payment (and CONTRACTOR shall furnish OWNER and each other additional insured identified in the Supplementary Conditions to whom a certificate of insurance has been issued evidence satisfactory to OWNER and any such additional insured of continuation of such insurance at final payment and one year thereafter).

OWNER's Liability Insurance:

5.5. In addition to the insurance required to be provided by CONTRACTOR under paragraph 5.4, OWNER, at OWNER's option, may purchase and maintain at OWNER's expense OWNER's own liability insurance as will protect OWNER against claims which may arise from operations under the Contract Documents.

Property Insurance:

5.6. Unless otherwise provided in the Supplementary Conditions, OWNER shall purchase and maintain property insurance upon the Work at the site in the amount of the full replacement cost thereof (subject to such deductible amounts as may be provided in the Supplementary Conditions or required by Laws and Regulations). This insurance shall:

5.6.1. include the interests of OWNER, CONTRACTOR, Subcontractors, ENGINEER, ENGINEER's Consultants and any other persons or entities identified in the Supplementary Conditions, each of whom is deemed to have an insurable interest and shall be listed as an insured or additional insured;

5.6.2. be written on a Builder's Risk "all-risk" or open peril or special causes of loss policy form that shall at least include insurance for physical loss or damage to the Work, temporary buildings, false work and Work in transit and shall insure against at least the following perils fire, lightning, extended coverage, theft, vandalism and malicious mischief, earthquake, collapse, debris removal, demolition occasioned by enforcement of Laws and Regulations, water damage, and such other perils as may be specifically required by the Supplementary Conditions;

5.6.3. include expenses incurred in the repair or replacement of any insured property (including but not limited to fees and charges of engineers and architects);

5.6.4. cover materials and equipment stored at the site or at another location that was agreed to in writing by OWNER prior to being incorporated in the Work, provided that such materials and equipment have been included in an Application for Payment recommended by ENGINEER; and

5.6.5. be maintained in effect until final payment is made unless otherwise agreed to in writing by OWNER, CONTRACTOR and ENGINEER with thirty days written notice to each other additional insured to whom a certificate of insurance has been issued.

5.7. OWNER shall purchase and maintain such boiler and machinery insurance or additional property insurance as may be required by the Supplementary Conditions or Laws and Regulations which will include the interests of OWNER, CONTRACTOR, Subcontractors, ENGINEER, ENGINEER's Consultants and any other persons or entities identified in the Supplementary Conditions, each of whom is deemed to have an insurable interest and shall be listed as an insured or additional insured.

5.8. All the policies of insurance (and the certificates or other evidence thereof) required to be purchased and maintained by OWNER in accordance with paragraphs 5.6 and 5.7 will contain a provision or endorsement that the coverage afforded will not be canceled or materially changed or renewal refused until at least thirty days' prior written notice has been given to OWNER and CONTRACTOR and to each other additional insured to whom a certificate of insurance has been issued and will contain waiver provisions in accordance with paragraph 5.11.

5.9. OWNER shall not be responsible for purchasing and maintaining any property insurance to protect the interests of CONTRACTOR, Subcontractors or others in the Work to the extent of any deductible amounts that are identified in the Supplementary Conditions. The risk of loss within such identified deductible amount, will be borne by CONTRACTOR, Subcontractor or others suffering any such loss and if any of them wishes property insurance coverage within the limits of such amounts, each may purchase and maintain it at the purchaser's own expense.

5.10. If CONTRACTOR requests in writing that other special insurance be included in the property insurance policies provided under paragraphs 5.6 or 5.7, OWNER shall, if possible, include such insurance, and the cost thereof will be charged to CONTRACTOR by appropriate Change Order or Written Amendment. Prior to commencement of the Work at the site, OWNER shall in writing advise CONTRACTOR whether or not such other insurance has been procured by OWNER.

5.11. Waiver of Rights:

5.11.1. OWNER and CONTRACTOR intend that all policies purchased in accordance with paragraphs 5.6 and 5.7 will protect OWNER, CONTRACTOR, Subcontractors, ENGINEER, ENGINEER's Consultants and all other persons or entities identified in the Supplementary Conditions to be listed as insureds or additional insureds in such policies and will provide primary coverage for all losses and damages caused by the perils covered thereby. All such policies shall contain provisions to the effect that in the event of payment of any loss or damage the insurers will have no rights of recovery against any of the insureds or additional insureds thereunder. OWNER and CONTRACTOR waive all rights against each other and their respective officers, directors, employees and agents for all losses and damages caused by, arising out of or resulting from any of the perils covered by such policies and any other property insurance applicable to the Work; and, in addition, waive all such rights against Subcontractors, ENGINEER, ENGINEER's Consultants and all other persons or entities identified in the Supplementary Conditions to be listed as insureds or additional insureds under such policies for losses and damages so caused. None of the above waivers shall extend to the

rights that any party making such waiver may have to the proceeds of insurance held by OWNER as trustee or otherwise payable under any policy so issued.

5.11.2. In addition, OWNER waives all rights against CONTRACTOR, Subcontractors, ENGINEER, ENGINEER'S Consultants and the officers, directors, employees and agents of any of them, for:

5.11.2.1. loss due to business interruption, loss of use or other consequential loss extending beyond direct physical loss or damage to OWNER's property or the Work caused by, arising out of or resulting from fire or other peril, whether or not insured by OWNER; and

5.11.2.2. loss or damage to the completed Project or part thereof caused by, arising out of or resulting from fire or other insured peril covered by any property insurance maintained on the completed Project or part thereof by OWNER during partial utilization pursuant to paragraph 14.10, after substantial completion pursuant to paragraph 14.8 or after final payment pursuant to paragraph 14.13.

Any insurance policy maintained by OWNER covering any loss, damage or consequential loss referred to in this paragraph 5.11.2 shall contain provisions to the effect that in the event of payment of any such loss, damage or consequential loss the insurers will have no rights of recovery against any of CONTRACTOR, Subcontractors, ENGINEER, ENGINEER'S Consultants and the officers, directors, employees and agents of any of them.

Receipt and Application of Insurance Proceeds

5.12. Any insured loss under the policies of insurance required by paragraphs 5.6 and 5.7 will be adjusted with OWNER and made payable to OWNER as fiduciary for the insureds, as their interests may appear, subject to the requirements of any applicable mortgage clause and of paragraph 5.13. OWNER shall deposit in a separate account any money so received, and shall distribute it in accordance with such agreement as the parties in interest may reach. If no other special agreement is reached the damaged Work shall be repaired or replaced, the moneys so received applied on account thereof and the Work and the cost thereof covered by an appropriate Change Order or Written Amendment.

5.13. OWNER as fiduciary shall have power to adjust and settle any loss with the insurers unless one of the parties in interest shall object in writing within fifteen days after the occurrence of loss to OWNER's exercise of this power. If such objection be made, OWNER as fiduciary shall make settlement with the insurers in accordance with such agreement as the parties in interest may reach. If no such agreement among the parties in interest is reached, OWNER as fiduciary shall adjust and settle the loss with the insurers and, if required in writing by any party in interest, OWNER as fiduciary shall give bond for the proper performance of such duties.

Acceptance of Bonds and Insurance; Option to Replace;

5.14. If either party (OWNER or CONTRACTOR) has any objection to the coverage afforded by or other provisions of the Bonds or insurance required to be purchased and maintained by the other party in accordance with Article 5 on the basis of non-conformance with the Contract Documents, the objecting party shall so notify the other party in writing within ten days after receipt of the certificates (or other evidence requested) required by paragraph 2.7. OWNER and

CONTRACTOR shall each provide to the other such additional information in respect of insurance provided as the other may reasonably request. If either party does not purchase or maintain all of the Bonds and insurance required of such party by the Contract Documents, such party shall notify the other party in writing of such failure to purchase prior to the start of the Work, or of such failure to maintain prior to any change in the required coverage. Without prejudice to any other right or remedy, the other party may elect to obtain equivalent Bonds or insurance to protect such other party's interests at the expense of the party who was required to provide such coverage, and a Change Order shall be issued to adjust the Contract Price accordingly.

Partial Utilization--Property Insurance:

5.15. If OWNER finds it necessary to occupy or use a portion or portions of the Work prior to Substantial Completion of all the Work, such use or occupancy may be accomplished in accordance with paragraph 14.10; provided that no such use or occupancy shall commence before the insurers providing the property insurance have acknowledged notice thereof and in writing effected any changes in coverage necessitated thereby. The insurers providing the property insurance shall consent by endorsement on the policy or policies, but the property insurance shall not be cancelled or permitted to lapse on account of any such partial use or occupancy.

ARTICLE 6--CONTRACTOR'S RESPONSIBILITIES

Supervision and Superintendence:

6.1. CONTRACTOR shall supervise, inspect and direct the Work competently and efficiently, devoting such attention thereto and applying such skills and expertise as may be necessary to perform the Work in accordance with the Contract Documents. CONTRACTOR shall be solely responsible for the means, methods, techniques, sequences and procedures of construction, but CONTRACTOR shall not be responsible for the negligence of others in the design or specification of a specific means, method, technique, sequence or procedure of construction which is shown or indicated in and expressly required by the Contract Documents. CONTRACTOR shall be responsible to see that the completed Work complies accurately with the Contract Documents.

6.2. CONTRACTOR shall keep on the Work at all times during its progress a competent resident superintendent, who shall not be replaced without written notice to OWNER and ENGINEER except under extraordinary circumstances. The superintendent will be CONTRACTOR's representative at the site and shall have authority to act on behalf of CONTRACTOR. All communications to the superintendent shall be as binding as if given to CONTRACTOR.

Labor, Materials and Equipment:

6.3. CONTRACTOR shall provide competent, suitably qualified personnel to survey, lay out and construct the Work as required by the Contract Documents. CONTRACTOR shall at all times maintain good discipline and order at the site. Except as otherwise required for the safety or protection of persons or the Work or property at the site or adjacent thereto, and except as otherwise indicated in the Contract Documents, all Work at the site shall be performed during regular working hours and CONTRACTOR will not permit overtime work or the performance of Work on Saturday, Sunday or any legal holiday without OWNER's written consent given after prior written notice to ENGINEER.

6.4. Unless otherwise specified in the General Requirements, CONTRACTOR shall furnish and assume full responsibility for all materials, equipment, labor, transportation, construction equipment and machinery, tools, appliances, fuel, power, light, heat, telephone, water sanitary facilities, temporary facilities and all other facilities and incidentals necessary for the furnishing, performance, testing, start-up and completion of the Work.

6.5. All materials and equipment shall be of good quality and new, except as otherwise provided in the Contract Documents. All warranties and guarantees specifically called for by the Specifications shall expressly run to the benefit of OWNER. If required by ENGINEER, CONTRACTOR shall furnish satisfactory evidence (including reports of required tests) as to the kind and quality of materials and equipment. All materials and equipment shall be applied, installed, connected, erected, used, cleaned and conditioned in accordance with instructions of the applicable Supplier, except as otherwise provided in the Contract Documents.

Progress Schedule:

6.6. CONTRACTOR shall adhere to the progress schedule established in accordance with paragraph 2.9 as it may be adjusted from time to time as provided below:

6.6.1. CONTRACTOR shall submit to ENGINEER for acceptance (to the extent indicated in paragraph 2.9) proposed adjustments in the progress schedule that will not change the Contract Times (or Milestones). Such adjustments will conform generally to the progress schedule then in effect and additionally will comply with any provisions of the General Requirements applicable thereto.

6.6.2. Proposed adjustments in the progress schedule that will change the Contract Times (or Milestones) shall be submitted in accordance with the requirements of paragraph 12.1. Such adjustments may only be made by a Change Order or Written Amendment in accordance with Article 12.

6.7. Substitutes and "Or-Equal" Items:

6.7.1. Whenever an item of material or equipment is specified or described in the Contract Documents by using the name of a proprietary item or the name of a particular Supplier, the specification or description is intended to establish the type, function and quality required. Unless the specification or description contains or is followed by words reading that no like, equivalent or "or-equal" item or no substitution is permitted, other items of material or equipment or material or equipment of other Suppliers may be accepted by ENGINEER under the following circumstances:

6.7.1.1. *"Or-Equal"*: If in ENGINEER's sole discretion an item of material or equipment proposed by CONTRACTOR is functionally equal to that named and sufficiently similar so that no change in related Work will be required, it may be considered by ENGINEER as an "or-equal" item, in which case review and approval of the proposed item may, in ENGINEER's sole discretion, be accomplished without compliance with some or all of the requirements for acceptance of proposed substitute items.

6.7.1.2. *Substitute Items*: If in ENGINEER's sole discretion an item of material or equipment proposed by CONTRACTOR does not qualify as an "or-equal" item under

subparagraph 6.7.1.1., it will be considered a proposed substitute item. CONTRACTOR shall submit sufficient information as provided below to allow ENGINEER to determine that the item of material or equipment proposed is essentially equivalent to that named and an acceptable substitute therefore. The procedure for review by the ENGINEER will include the following as supplemented in the General Requirements and as ENGINEER may decide is appropriate under the circumstances. Requests for review of proposed substitute items of material or equipment will not be accepted by ENGINEER from anyone other than CONTRACTOR. If CONTRACTOR wishes to furnish or use a substitute item of material or equipment, CONTRACTOR shall first make written application to ENGINEER for acceptance thereof, certifying that the proposed substitute will perform adequately the functions and achieve the results called for by the general design, be similar in substance to that specified and be suited to the same use as that specified. The application will state the extent, if any, to which the evaluation and acceptance of the proposed substitute will prejudice CONTRACTOR's achievement of Substantial Completion on time, whether or not acceptance of the substitute for use in the Work will require a change in any of the Contract Documents (or in the provisions of any other direct contract with OWNER for work on the Project) to adapt the design to the proposed substitute and whether or not incorporation or use of the substitute in connection with the Work is subject to payment of any license fee or royalty. All variations of the proposed substitute from that specified will be identified in the application and available maintenance, repair and replacement service will be indicated. The application will also contain an itemized estimate of all costs or credits that will result directly or indirectly from acceptance of such substitute, including costs of redesign and claims of other contractors affected by the resulting change, all of which will be considered by ENGINEER in evaluating the proposed substitute. ENGINEER may require CONTRACTOR to furnish additional data about the proposed substitute.

6.7.1.3. *CONTRACTOR's Expense*: All data to be provided by CONTRACTOR in support of any proposed "or-equal" or substitute item will be at CONTRACTOR's expense.

6.7.2. *Substitute Construction Methods or Procedures*: If a specific means, method, technique, sequence or procedure of construction is shown or indicated in and expressly required by the Contract Documents, CONTRACTOR may furnish or utilize a substitute means, method, technique, sequence or procedure of construction acceptable to ENGINEER. CONTRACTOR shall submit sufficient information to allow ENGINEER, in ENGINEER's sole discretion, to determine that the substitute proposed is equivalent to that expressly called for by the Contract Documents. The procedure for review by ENGINEER will be similar to that provided in subparagraph 6.7.1.2.

6.7.3. *Engineer's Evaluation*: ENGINEER will be allowed a reasonable time within which to evaluate each proposal or submittal made pursuant to paragraphs 6.7.1.2 and 6.7.2. ENGINEER will be the sole judge of acceptability. No "or-equal" or substitute will be ordered, installed or utilized without ENGINEER's prior written acceptance which will be evidenced by either a Change Order or an approved Shop Drawing. OWNER may require CONTRACTOR to furnish at CONTRACTOR's expense a special performance guarantee or other surety with respect to any "or-equal" or substitute. ENGINEER will record time required by ENGINEER and ENGINEER's Consultants in

evaluating substitutes proposed or submitted by CONTRACTOR pursuant to paragraphs 6.7.1.2 and 6.7.2 and in making changes in the Contract Documents (or in the provisions of any other direct contract with OWNER for work on the Project) occasioned thereby. Whether or not ENGINEER accepts a substitute item so proposed or submitted by CONTRACTOR, CONTRACTOR shall reimburse OWNER for the charges of ENGINEER and ENGINEER's Consultants for evaluating each such proposed substitute item.

Concerning Subcontractors, Suppliers and Others:

6.8.1. CONTRACTOR shall not employ any Subcontractor, Supplier or other person or organization (including those acceptable to OWNER and ENGINEER as indicated in paragraph 6.8.2), whether initially or as a substitute, against whom OWNER or ENGINEER may have reasonable objection. CONTRACTOR shall not be required to employ any Subcontractor, Supplier or other person or organization to furnish or perform any of the Work against whom CONTRACTOR has reasonable objection.

6.8.2. If the Supplementary Conditions require the identity of certain Subcontractors, Suppliers or other persons or organization (including those who are to furnish the principal items of materials or equipment) to be submitted to OWNER in advance of the specified date prior to the Effective Date of the Agreement for acceptance by OWNER and ENGINEER, and if CONTRACTOR has submitted a list thereof in accordance with the Supplementary Conditions, OWNER's or ENGINEER's acceptance (either in writing or by failing to make written objection thereto by the date indicated for acceptance or objection in the bidding documents or the Contract Documents) of any such Subcontractor, Supplier or other person or organization so identified may be removed on the basis of reasonable objection after due investigation, in which case CONTRACTOR shall submit an acceptable substitute, the Contract Price will be adjusted by the difference in the cost occasioned by such substitution and an appropriate Change Order will be issued or Written Amendment signed. No acceptance by OWNER or ENGINEER of any such Subcontractor, Supplier or other person or organization shall constitute a waiver of any right of OWNER or ENGINEER to reject *defective* Work.

6.9.1. CONTRACTOR shall be fully responsible to OWNER and ENGINEER for all acts and omissions of the Subcontractors, Suppliers and other persons and organizations performing or furnishing any of the Work under a direct or indirect contract with CONTRACTOR just as CONTRACTOR is responsible for CONTRACTOR's own acts and omissions. Nothing in the Contract Documents shall create for the benefit of any such Subcontractor, Supplier or other person or organization any contractual relationship between OWNER and ENGINEER and any such Subcontractor, Supplier or other person or organization, nor shall it create any obligation on the part of OWNER or ENGINEER to pay or to see to the payment of any moneys due any such Subcontractor, Supplier or other person or organization except as may otherwise be required by Laws and Regulations.

6.9.2. CONTRACTOR shall be solely responsible for scheduling and coordinating the Work of Subcontractors, Suppliers and other persons and organizations performing or furnishing any of the Work under a direct or indirect contract with CONTRACTOR. CONTRACTOR shall require all Subcontractors, Suppliers and such other persons and organizations performing or furnishing any of the Work to communicate with the ENGINEER through CONTRACTOR.

6.10. The divisions and sections of the Specifications and the identifications of any Drawings shall not control CONTRACTOR in dividing the Work among Subcontractors or Suppliers or delineating the Work to be performed by any specific trade.

6.11. All Work performed for CONTRACTOR by a Subcontractor or Supplier will be pursuant to an appropriate agreement between CONTRACTOR and the Subcontractor or Supplier which specifically binds the Subcontractor or Supplier to the applicable terms and conditions of the Contract Documents for the benefit of OWNER and ENGINEER. Whenever any such agreement is with a Subcontractor or Supplier who is listed as an additional insured on the property insurance provided in paragraph 5.6 or 5.7, the agreement between the CONTRACTOR and the Subcontractor or Supplier will contain provisions whereby the Subcontractor or Supplier waives all rights against OWNER, CONTRACTOR, ENGINEER, ENGINEER's Consultants and all other additional insureds for all losses and damages caused by, arising out of or resulting from any of the perils covered by such policies and any other property insurance applicable to the Work. If the insurers on any such policies require separate waiver forms to be signed by any Subcontractor or Supplier, CONTRACTOR will obtain the same.

Patent Fees and Royalties:

6.12. CONTRACTOR shall pay all license fees and royalties and assume all costs incident to the use in the performance of the Work or the incorporation in the Work of any invention, design, process, product or device which is the subject of patent rights or copyrights held by others. If a particular invention, design, process, product or device is specified in the Contract Documents for use in the performance of the Work and if to the actual knowledge of OWNER or ENGINEER its use is subject to patent rights or copyrights calling for the payment of any license fee or royalty to others, the existence of such rights shall be disclosed by OWNER in the Contract Documents. To the fullest extent permitted by Laws and Regulations, CONTRACTOR shall indemnify and hold harmless OWNER, ENGINEER, ENGINEER's Consultants and the officers, directors, employees, agents and other consultants of each and any of them from and against all claims, costs, losses and damages arising out of or resulting from any infringement of patent rights or copyrights incident to the use in the performance of the Work or resulting from the incorporation in the Work of any invention, design, process, product or device not specified in the Contract Documents.

Permits:

6.13. Unless otherwise provided in the Supplementary Conditions, CONTRACTOR shall obtain and pay for all construction permits and licenses. OWNER shall assist CONTRACTOR, when necessary, in obtaining such permits and licenses. CONTRACTOR shall pay all governmental charges and inspection fees necessary for the prosecution of the Work, which are applicable at the time of opening of Bids, or, if there are no Bids, on the Effective Date of the Agreement. CONTRACTOR shall pay all charges of utility owners for connections to the Work, and OWNER shall pay all charges of such utility owners for capital costs related thereto such as plant investment fees.

Laws and Regulations:

6.14.1. CONTRACTOR shall give all notices and comply with all Laws and Regulations applicable to furnishing and performance of the Work. Except where otherwise expressly required by applicable Laws and Regulations, neither OWNER nor ENGINEER shall be responsible for monitoring CONTRACTOR's compliance with any Laws or Regulations.

6.14.2. If CONTRACTOR performs any Work knowing or having reason to know that it is contrary to Laws or Regulations, CONTRACTOR shall bear all claims, costs, losses and damages caused by, arising out of or resulting there from; however, it shall not be CONTRACTOR's primary responsibility to make certain that the Specifications and Drawings are in accordance with Laws and Regulations, but this shall not relieve CONTRACTOR or CONTRACTOR's obligations under paragraph 3.3.2.

Taxes:

6.15. CONTRACTOR shall pay all sales, consumer, use and other similar taxes required to be paid by CONTRACTOR in accordance with Laws and Regulations of the place of the Project which are applicable during the performance of the Work.

Use of Premises:

6.16. CONTRACTOR shall confine construction equipment, the storage of materials and equipment and the operations of workers to the site and land and areas identified in and permitted by the Contract Documents and other land and areas permitted by Laws and Regulations, rights-of-way, permits and easements, and shall not unreasonably encumber the premises with construction equipment or other materials or equipment. CONTRACTOR shall assume full responsibility for any damage to any such land or area, or to the owner or occupant thereof or of any adjacent land or areas, resulting from the performance of the Work. Should any claim be made by any such owner or occupant because of the performance of the Work, CONTRACTOR shall promptly settle with such other party by negotiation or otherwise resolve the claim by arbitration or other dispute resolution proceeding or at law. CONTRACTOR shall, to the fullest extent permitted by Laws and Regulations, indemnify and hold harmless OWNER, ENGINEER, ENGINEER's Consultant and anyone directly or indirectly employed by any of them from and against all claims, costs, losses and damages arising out of or resulting from any claim or action, legal or equitable, brought by any such owner or occupant against OWNER, ENGINEER or any other party indemnified hereunder to the extent caused by or based upon CONTRACTOR's performance of the Work.

6.17. During the progress of the Work, CONTRACTOR shall keep the premises free from accumulations of waste materials, rubbish and other debris resulting from the Work. At the completion of the Work CONTRACTOR shall remove all waste materials, rubbish and debris from and about the premises as well as all tools, appliances, construction equipment and machinery and surplus materials. CONTRACTOR shall leave the site clean and ready for occupancy by OWNER at Substantial Completion of the Work. CONTRACTOR shall restore to original condition all property not designated for alteration by the Contract Documents.

6.18. CONTRACTOR shall not load nor permit any part of any structure to be loaded in any manner that will endanger the structure, nor shall CONTRACTOR subject any part of the Work or adjacent property to stresses or pressures that will endanger it.

Record Documents:

6.19. CONTRACTOR shall maintain in a safe place at the site one record copy of all Drawings, Specifications, Addenda, Written Amendments, Change Orders, Work Change Directives, Field Orders and written interpretations and clarifications (issued pursuant to paragraph 9.4) in good order and annotated to show all changes made during construction. These record documents together with all

approved Samples and a counter part of all approved Shop Drawings will be available to ENGINEER for reference. Upon completion of the Work, these record documents, Samples and Shop Drawings will be delivered to ENGINEER for OWNER.

Safety and Protection:

6.20. CONTRACTOR shall be responsible for initiating, maintaining and supervising all safety precautions and programs in connection with the Work. CONTRACTOR shall take all necessary precautions for the safety of, and shall provide the necessary protection to prevent damage, injury or loss to:

6.20.1. all persons on the Work site or who may be affected by the Work;

6.20.2. all the Work and materials and equipment to be incorporated therein, whether in storage on or off the site; and

6.20.3. other property at the site or adjacent thereto, including trees, shrubs, lawns, walks, pavements, roadways, structures, utilities and Underground Facilities not designated for removal, relocation or replacement in the course of construction.

CONTRACTOR shall comply with all applicable Laws and Regulations of any public body having jurisdiction for safety of persons or property or to protect them from damage, injury or loss; and shall erect and maintain all necessary safeguards for such safety and protection. CONTRACTOR shall notify owners of adjacent property and of Underground Facilities and utility owners when prosecution of the Work may affect them, and shall cooperate with them in the protection, removal, relocation and replacement of their property. All damage, injury or loss to any property referred to in paragraph 6.20.2 or 6.20.3 caused, directly or indirectly, in whole or in part, by CONTRACTOR, any Subcontractor, Supplier or any other person or organization directly or indirectly employed by any of them to perform or furnish any of the Work or anyone for whose acts any of them may be liable, shall be remedied by CONTRACTOR (except damage or loss attributable to the fault of Drawings or Specifications or to the acts or omissions of OWNER or ENGINEER or ENGINEER's Consultant or anyone employed by any of them or anyone for whose acts any of them may be liable, and not attributable, directly or indirectly, in whole or in part, to the fault or negligence of CONTRACTOR or any Subcontractor, Supplier or other person or organization directly or indirectly employed by any of them). CONTRACTOR's duties and responsibilities for safety and for protection of the Work shall continue until such time as all the Work is completed and ENGINEER has issued a notice to OWNER and CONTRACTOR in accordance with paragraph 14.13 that the Work is acceptable (except as otherwise expressly provided in connection with Substantial Completion).

Safety Representative:

6.21. CONTRACTOR shall designate a qualified and experienced safety representative at the site whose duties and responsibilities shall be the prevention of accidents and the maintaining and supervising of safety precautions and programs.

Hazard Communication Program:

6.22. CONTRACTOR shall be responsible for coordinating any exchange of material safety data sheets or other hazard communication information required to be made available to or exchanged between or among employers at the site in accordance with Laws or Regulations.

Emergencies:

6.23. In emergencies affecting the safety or protection of persons or the Work or property at the site or adjacent thereto, CONTRACTOR, without special instruction or authorization from OWNER or ENGINEER, is obligated to act to prevent threatened damage, injury or loss. CONTRACTOR shall give ENGINEER prompt written notice if CONTRACTOR believes that any significant changes in the Work or variations from the Contract Documents have been caused thereby. If ENGINEER determines that a change in the Contract Documents is required because of the action taken by CONTRACTOR in response to such an emergency, a Work Change Directive or Change Order will be issued to document the consequences of such action.

6.24. Shop Drawings and Samples:

6.24.1. CONTRACTOR shall submit Shop Drawings to ENGINEER for review and approval in accordance with the accepted schedule of Shop Drawings and Sample submittals (see paragraph 2.9). All submittals will be identified as ENGINEER may require and in the number of copies specified in the General Requirements. The data shown on the Shop Drawings will be complete with respect to quantities, dimensions, specified performance and design criteria, materials and similar data to show ENGINEER the materials and equipment CONTRACTOR proposes to provide and to enable ENGINEER to review the information for the limited purposes required by paragraph 6.26.

6.24.2. CONTRACTOR shall also submit Samples to ENGINEER for review and approval in accordance with said accepted schedule of Shop Drawings and Sample submittals. Each Sample will be identified clearly as to material, Supplier, pertinent data such as catalog numbers and the use for which intended and otherwise as ENGINEER may require to enable ENGINEER to review the submittal for the limited purposes required by paragraph 6.26. The numbers of each Sample to be submitted will be as specified in the Specifications.

6.25. Submittal Procedures:

6.25.1. Before submitting each Shop Drawing or Sample, CONTRACTOR shall have determined and verified:

6.25.1.1. all field measurements, quantities, dimensions, specified performance criteria, installation requirements, materials, catalog numbers and similar information with respect thereto.

6.25.1.2. all materials with respect to intended use, fabrication, shipping, handling, storage, assembly and installation pertaining to the performance of the Work, and

6.25.1.3. all information relative to CONTRACTOR's sole responsibilities in respect of means, methods, techniques, sequences and procedures of construction and safety precautions and programs incident thereto.

CONTRACTOR shall also have reviewed and coordinated each Shop Drawing or Sample with other Shop Drawings and Samples and with the requirements of the Work and the Contract Documents.

6.25.2. Each submittal will bear a stamp or specific written indication that CONTRACTOR has satisfied CONTRACTOR's obligations under the Contract Documents with respect to CONTRACTOR's review and approval of that submittal.

6.25.3. At the time of each submission, CONTRACTOR shall give ENGINEER specific written notice of such variations, if any, that the Shop Drawings or Sample submitted may have from the requirements of the Contract Documents, such notice to be in a written communication separate from the submittal; and, in addition, shall cause a specific notation to be made on each Shop Drawing and Sample submitted to ENGINEER for review and approval of each such variation.

6.26. ENGINEER will review and approve Shop Drawings and Samples in accordance with the schedule of Shop Drawings and Sample submittals accepted by ENGINEER as required by paragraph 2.9. ENGINEER's review and approval will be only to determine if the items covered by the submittals will, after installation or incorporation in the Work, conform to the information given in the Contract Documents and be compatible with the design concept of the completed project as a functioning whole as indicated by the Contract Documents. ENGINEER's review and approval will not extend to means, methods, techniques, sequences or procedures of construction (except where particular means, method, technique, sequence or procedure of construction is specifically and expressly called for by the Contract Documents) or to safety precautions or programs incident thereto. The review and approval of a separate item as such will not indicate approval of the assembly in which the item functions. CONTRACTOR shall make corrections required by ENGINEER, and shall return the required number of corrected copies of Shop Drawings and submit as required new Samples for review and approval. CONTRACTOR shall direct specific attention in writing to revisions other than the corrections called for by ENGINEER on previous submittals.

6.27. ENGINEER's review and approval of Shop Drawings or Samples shall not relieve CONTRACTOR from responsibility for any variation from the requirements of the Contract Documents unless CONTRACTOR has in writing called ENGINEER's attention to each such variation at the time of submission as required by paragraph 6.25.3 and ENGINEER has given written approval of each such variation by specific written notation thereof incorporated in or accompanying the Shop Drawing or Sample approval; nor will any approval by ENGINEER relieve CONTRACTOR from responsibility for complying with the requirements of paragraph 6.25.1.

6.28. Where a Shop Drawing or Sample is required by the Contract Documents or the schedule of Shop Drawings and Sample submissions accepted by ENGINEER as required by paragraph 2.9, any related Work performed prior to ENGINEER's review and approval of the pertinent submittal will be at the sole expense and responsibility of CONTRACTOR.

Continuing the Work:

6.29. CONTRACTOR shall carry on the Work and adhere to the progress schedule during all disputes or disagreements with OWNER. No Work shall be delayed or postponed pending resolution of any disputes or disagreements, except as permitted by paragraph 15.5 or as OWNER and CONTRACTOR may otherwise agree in writing.

6.30. CONTRACTOR's General Warranty and Guarantee

6.30.1. CONTRACTOR warrants and guarantees to OWNER, ENGINEER and ENGINEER's Consultants that all Work will be in accordance with the Contract Documents and will not be defective. CONTRACTOR's warranty and guarantee hereunder excludes defects or damage caused by:

6.30.1.1. abuse, modification or improper maintenance or operation by persons other than CONTRACTOR, Subcontractors or Suppliers; or

6.30.1.2. normal wear and tear under normal usage.

6.30.2. CONTRACTOR's obligation to perform and complete the Work in accordance with the Contract Documents shall be absolute. None of the following will constitute an acceptance of Work that is not in accordance with the Contract Documents or a release of CONTRACTOR's obligation to perform the Work in accordance with the Contract Documents:

6.30.2.1. observations by ENGINEER;

6.30.2.2. recommendation of any progress or final payment by ENGINEER;

6.30.2.3. the issuance of a certificate of Substantial Completion or any payment by OWNER to CONTRACTOR under the Contract Documents;

6.30.2.4. use or occupancy of the Work or any part thereof by OWNER;

6.30.2.5. any acceptance by OWNER or any failure to do so;

6.30.2.6. any review and approval of a Shop Drawing or Sample submittal or the issuance of a notice of acceptability by ENGINEER pursuant to paragraph 14.13;

6.30.2.7. any inspection, test or approval by others; or

6.30.2.8. any correction of *defective* Work by OWNER.

Indemnification:

6.31. To the fullest extent permitted by Laws and Regulations, CONTRACTOR shall indemnify and hold harmless OWNER, ENGINEER, ENGINEER's Consultants and the officers, directors, employees, agents and other consultants of each and any of them from and against all claims, costs, losses and damages (including but not limited to all fees and charges of engineers, architects, attorneys and other professionals and all court or arbitration or other dispute resolution costs) caused by, arising out of or resulting from the performance of the Work, provided that any such claim, cost, loss or damage: (i) is attributable to bodily injury, sickness, disease or death, or to injury to or destruction of tangible property (other than the Work itself), including the loss of use resulting there from, and (ii) is caused in whole or in part by any negligent act or omission of CONTRACTOR, any Subcontractor, any Supplier, any person or organization directly or indirectly employed by any of them to perform or furnish any of the Work or anyone for whose acts any of them may be liable, regardless of whether or not caused in part by any negligence or omission of a person or entity indemnified hereunder or whether liability is imposed upon such indemnified party by Laws and Regulations regardless of the negligence of any such person or entity.

6.32. In any and all claims against OWNER or ENGINEER or any of their respective consultants, agents, officers, directors or employees by any employee (or the survivor or personal representative of such employee) of CONTRACTOR, any Subcontractor, any Supplier, any person or organization directly or indirectly employed by any of them

to perform or furnish any of the Work, or anyone for whose acts any of them may be liable, the indemnification obligation under paragraph 6.31 shall not be limited in any way by any limitation on the amount or type of damages, compensation or benefits payable by or for CONTRACTOR or any such Subcontractor, Supplier or other person or organization under workers' compensation acts, disability benefit acts or other employee benefit acts.

6.33. The indemnification obligations of CONTRACTOR under paragraph 6.31 shall not extend to the liability of ENGINEER and ENGINEER's Consultants, officers, directors, employees or agents caused by the professional negligence errors or omissions of any of them.

Survival of Obligations:

6.34. All representatives, indemnifications, warranties and guarantees made in, required by or given in accordance with the Contract Documents, as well as all continuing obligations indicated in the Contract Documents, will survive final payment, completion and acceptance of the Work and termination or completion of the Agreement.

ARTICLE 7--OTHER WORK

Related Work at Site:

7.1. OWNER may perform other work related to the Project at the site by OWNER's own forces, or let other direct contracts therefore which shall contain General Conditions similar to these, or have other work performed by utility owners. If the fact that such other work is to be performed was not noted in the Contract Documents, then: (i) written notice thereof will be given to CONTRACTOR prior to starting any such other work, and (ii) CONTRACTOR may make a claim therefore as provided in Articles 11 and 12 if CONTRACTOR believes that such performance will involve additional expense to CONTRACTOR or requires additional time and the parties are unable to agree as to the amount or extent thereof.

7.2. CONTRACTOR shall afford each other contractor who is a party to such a direct contract and each utility owner (and OWNER, if OWNER is performing the additional work with OWNER's employees) proper and safe access to the site and a reasonable opportunity for the introduction and storage of materials and equipment and the execution of such other work and shall properly connect and coordinate the Work with theirs. Unless otherwise provided in the Contract Documents, CONTRACTOR shall do all cutting, fitting and patching of the Work that may be required to make its several parts come together properly and integrate with such other work. CONTRACTOR shall not endanger any work of others by cutting, excavating or otherwise altering their work and will only cut or alter their work with the written consent of ENGINEER and the others whose work will be affected. The duties and responsibilities of CONTRACTOR under this paragraph are for the benefit of such utility owners and other contractors to the extent that there are comparable provisions for the benefit of CONTRACTOR in said direct contracts between OWNER and such utility owners and other contractors.

7.3. If the proper execution or results of any part of CONTRACTOR's Work depends upon work performed by others under this Article 7, CONTRACTOR shall inspect such other work and promptly report to ENGINEER in writing any delays, defects or deficiencies in such other work that render it unavailable or unsuitable

for the proper execution and results of CONTRACTOR's Work. CONTRACTOR's failure so to report will constitute an acceptance of such other work as fit and proper for integration with CONTRACTOR's Work except for latent or nonapparent defects and deficiencies in such other work.

Coordination:

7.4. If OWNER contracts with others for the performance of other work on the Project at the site, the following will be set forth in Supplementary Conditions:

7.4.1. the person, firm or corporation who will have authority and responsibility for coordination of the activities among the various prime contractors will be identified;

7.4.2. the specific matters to be covered by such authority and responsibility will be itemized; and

7.4.3. the extent of such authority and responsibilities will be provided.

Unless otherwise provided in the Supplementary Conditions, OWNER shall have sole authority and responsibility in respect of such coordination.

ARTICLE 8--OWNER'S RESPONSIBILITIES

8.1. Except as otherwise provided in these General Conditions, OWNER shall issue all communications to CONTRACTOR through ENGINEER.

8.2. In case of termination of the employment of ENGINEER, OWNER shall appoint an engineer against whom CONTRACTOR makes no reasonable objection, whose status under the Contract Documents shall be that of the former ENGINEER.

8.3. OWNER shall furnish the data required of OWNER under the Contract Documents promptly and shall make payments to CONTRACTOR promptly when they are due as provided in paragraphs 14.4 and 14.13.

8.4. OWNER's duties in respect of providing lands and easements and providing engineering surveys to establish reference points are set forth in paragraphs 4.1 and 4.4. Paragraph 4.2 refers to OWNER's identifying and making available to CONTRACTOR copies of reports of explorations and tests of subsurface conditions at the site and drawings of physical conditions in existing structures at or contiguous to the site that have been utilized by ENGINEER in preparing the Contract Documents.

8.5. OWNER's responsibilities in respect of purchasing and maintaining liability and property insurance are set forth in paragraphs 5.5 through 5.10.

8.6. OWNER is obligated to execute Change Orders as indicated in paragraph 10.4.

8.7. OWNER's responsibility in respect of certain inspections, tests and approvals is set forth in paragraph 13.4.

8.8. In connection with OWNER's right to stop Work or suspend Work, see paragraphs 13.10 and 15.1. Paragraph 15.2 deals with OWNER's right to terminate services of CONTRACTOR under certain circumstances.

8.9. The OWNER shall not supervise, direct or have control or authority over, nor be responsible for, CONTRACTOR's means, methods, techniques, sequences or procedures of construction or the safety precautions and programs incident thereto, or for any failure of CONTRACTOR to comply with Laws and Regulations applicable to the furnishing or performance of the Work. OWNER will not be responsible for CONTRACTOR's failure to perform or furnish the Work in accordance with the Contract Documents.

8.10. OWNER's responsibility in respect of undisclosed Asbestos, PCBs, Petroleum, Hazardous Waste or Radioactive Materials uncovered or revealed at the site is set forth in paragraph 4.5.

8.11. If and to the extent OWNER has agreed to furnish CONTRACTOR reasonable evidence that financial arrangements have been made to satisfy OWNER's obligations under the Contract Documents, OWNER's responsibility in respect thereof will be as set forth in the Supplementary Conditions.

ARTICLE 9--ENGINEER'S STATUS DURING CONSTRUCTION

OWNER's Representative:

9.1. ENGINEER will be OWNER's representative during the construction period. The duties and responsibilities and the limitations of authority of ENGINEER as OWNER's representative during construction are set forth in the Contract Documents and shall not be extended without written consent of OWNER and ENGINEER.

Visits to Site:

9.2. ENGINEER will make visits to the site at intervals appropriate to the various stages of construction as ENGINEER deems necessary in order to observe as an experienced and qualified design professional the progress that has been made and the quality of the various aspects of CONTRACTOR's executed Work. Based on information obtained during such visits and observations, ENGINEER will endeavor for the benefit of OWNER to determine, in general, if the Work is proceeding in accordance with the Contract Documents. ENGINEER will not be required to make exhaustive or continuous on-site inspections to check the quality or quantity of the Work. ENGINEER's efforts will be directed toward providing for OWNER a greater degree of confidence that the completed Work will conform generally to the Contract Documents. On the basis of such visits and on-site observations, ENGINEER will keep OWNER informed of the progress of the Work and will endeavor to guard OWNER against defective Work. ENGINEER's visits and on-site observations are subject to all the limitations on ENGINEER's authority and responsibility set forth in paragraph 9.13, and particularly, but without limitation, during or as a result of ENGINEER's on-site visits or observations of CONTRACTOR's Work ENGINEER will not supervise, direct, control or have authority over or be responsible for CONTRACTOR's means, methods, techniques, sequences or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of CONTRACTOR to comply with Laws and Regulations applicable to the furnishing or performance of the Work.

Project Representative:

9.3. If OWNER and ENGINEER agree, ENGINEER will furnish a Resident Project Representative to assist ENGINEER in providing more continuous observation of the Work. The responsibilities and authority and limitations thereon of any such Resident Project Representative and assistants will be as provided in paragraph 9.13 and in the Supplementary Conditions. If OWNER designates another representative or agent to represent OWNER at the site who is not ENGINEER's Consultant, agent or employee, the responsibilities and authority and limitations thereon of such other person will be as provided in the Supplementary Conditions.

Clarifications and Interpretations:

9.4. ENGINEER will issue with reasonable promptness such written clarifications or interpretations of the requirements of the Contract Documents (in the form of Drawings or otherwise) as ENGINEER may determine necessary, which shall be consistent with the intent of and reasonably inferable from Contract Documents. Such written clarifications and interpretations will be binding on OWNER and CONTRACTOR. If OWNER or CONTRACTOR believes that a written clarification or interpretation justifies an adjustment in the Contract Price or the Contract Times and the parties are unable to agree to the amount or extent thereof, if any, OWNER or CONTRACTOR may make a written claim therefore as provided in Article 11 or Article 12.

Authorized Variations in Work:

9.5. ENGINEER may authorize minor variations in the Work from the requirements of the Contract Documents which do not involve an adjustment in the Contract Price or the Contract Times and are compatible with the design concept of the completed Project as a functioning whole as indicated by the Contract Documents. These may be accomplished by a Field Order and will be binding on OWNER and also on CONTRACTOR who shall perform the Work involved promptly. If OWNER or CONTRACTOR believes that a Field Order justifies an adjustment in the Contract Price or the Contract Times and the parties are unable to agree as to the amount or extent thereof, OWNER or CONTRACTOR may make a written claim therefore as provided in Article 11 or 12.

Rejecting Defective Work:

9.6. ENGINEER will have authority to disapprove or reject Work which ENGINEER believes to be *defective*, or that ENGINEER believes will not produce a completed Project that conforms to the Contract Documents or that will prejudice the integrity of the design concept of the completed Project as a functioning whole as indicated by the Contract Documents. ENGINEER will also have authority to require special inspection or testing of the Work as provided in paragraph 13.9, whether or not the Work is fabricated, installed or completed.

Shop Drawings, Change Orders and Payments:

9.7. In connection with ENGINEER's authority as to Shop Drawings and Samples, see paragraphs 6.24 through 6.28 inclusive.

9.8. In connection with ENGINEER's authority as to Change Orders, see Articles 10, 11, and 12.

9.9. In connection with ENGINEER's authority as to Applications for Payment, see Article 14.

Determinations for Unit Price:

9.10. ENGINEER will determine the actual quantities and classifications of Unit Price Work performed by CONTRACTOR. ENGINEER will review with CONTRACTOR the ENGINEER's preliminary determinations on such matters before rendering a written decision thereon (by recommendation of an Application for Payment or otherwise). ENGINEER's written decision thereon will be final and binding upon OWNER and CONTRACTOR, unless, within ten days after the date of any such decision, either OWNER or CONTRACTOR delivers to the other and to ENGINEER written notice of intention to appeal from ENGINEER's decision and: (i) an appeal from ENGINEER's decision is taken within the time limits and in accordance with the procedures set forth in Exhibit GC-A, "Dispute Resolution Agreement," entered into between OWNER and CONTRACTOR pursuant to Article 16, or (ii) if no such Dispute Resolution Agreement has been entered into, a formal proceeding is instituted by the appealing party in a forum of competent jurisdiction to exercise such rights or remedies as the appealing party may have with respect to ENGINEER's decision, unless otherwise agreed in writing by OWNER and CONTRACTOR. Such appeal will not be subject to the procedures of paragraph 9.11.

Decisions on Disputes:

9.11. ENGINEER will be the initial interpreter of the requirements of the Contract Documents and judge of the acceptability of the Work thereunder. Claims, disputes and other matters relating to the acceptability of the Work or the interpretation of the requirements of the Contract Documents pertaining to the performance and furnishing of the Work and Claims under Articles 11 and 12 in respect of changes in the Contract Price or Contract Times will be referred initially to ENGINEER in writing with a request for a formal decision in accordance with this paragraph. Written notice of each such claim, dispute or other matter will be delivered by the claimant to ENGINEER and the other party to the Agreement promptly (but in no event later than thirty days) after the start of the occurrence or event giving rise thereto, and written supporting data will be submitted to ENGINEER and the other party within sixty days after the start of such occurrence or event unless ENGINEER allows an additional period of time for the submission of additional or more accurate data in support of such claim, dispute or other matter. The opposing party shall submit any response to ENGINEER and the claimant within thirty days after receipt of the claimant's last submittal (unless ENGINEER allows additional time). ENGINEER will render a formal decision in writing within thirty days after receipt of the opposing party's submittal, if any, in accordance with this paragraph. ENGINEER's written decision on such claim, dispute or other matter will be final and binding upon OWNER and CONTRACTOR unless: (i) an appeal from ENGINEER's decision is taken within the time limits and in accordance with the procedures set forth in EXHIBIT GC-A, "Dispute Resolution Agreement," entered into between OWNER and CONTRACTOR pursuant to Article 16, or (ii) if no such Dispute Resolution Agreement has been entered into, a written notice of intention to appeal from ENGINEER's written decision is delivered by OWNER or CONTRACTOR to the other and to ENGINEER within thirty days after the date of such decision and a formal proceeding is instituted by the appealing party in a forum of competent jurisdiction to exercise such rights or remedies as the appealing party may have with respect to such claim, dispute or other matter in accordance with applicable Laws and Regulations within sixty days of the date of such decision, unless otherwise agreed in writing by OWNER and CONTRACTOR.

9.12. When functioning as interpreter and judge under paragraphs 9.10 and 9.11, ENGINEER will not show partiality to OWNER or CONTRACTOR and will not be liable in connection with any interpretation or decision rendered in good faith in such capacity. The rendering of a decision by ENGINEER pursuant to paragraphs 9.10 or

9.11 with respect to any such claim, dispute or other matter (except any which have been waived by the making or acceptance of final payment as provided in paragraph 14.16) will be a condition precedent to any exercise by OWNER or CONTRACTOR of such rights or remedies as either may otherwise have under the Contract Documents or by Laws or Regulations in respect of any such claim, dispute or other matter pursuant to Article 16.

9.13. Limitations on ENGINEER's Authority and Responsibilities:

9.13.1. Neither ENGINEER's authority or responsibility under this Article 9 or under any other provision of the Contract Documents nor any decision made by ENGINEER in good faith either to exercise or not exercise such authority or responsibility or the undertaking, exercise or performance of any authority or responsibility by ENGINEER shall create, impose or give rise to any duty owed by ENGINEER to CONTRACTOR, any Subcontractor, any Supplier, any other person or organization, or to any surety for or employee or agent of any of them.

9.13.2. ENGINEER will not supervise, direct, control or have authority over or be responsible for CONTRACTOR's means, methods, techniques, sequences or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of CONTRACTOR to comply with Laws and Regulations applicable to the furnishing or performance of the Work. ENGINEER will not be responsible for CONTRACTOR's failure to perform or furnish the Work in accordance with the Contract Documents.

9.13.3. ENGINEER will not be responsible for the acts or omissions of CONTRACTOR or of any Subcontractor, any Supplier, or of any other person or organization performing or furnishing any of the Work.

9.13.4. ENGINEER's review of the final Application for Payment and accompanying documentation and all maintenance and operating instructions, schedules, guarantees, bonds and certificates of inspection, tests and approvals and Other documentation required to be delivered by paragraph 14.12 will only be to determine generally that their content complies with the requirements of, and in the case of certificates of inspections, tests and approvals that the results certified indicate compliance with, the Contract Documents.

9.13.5. The limitations upon authority and responsibility set forth in this paragraph 9.13 shall also apply to ENGINEER's Consultants, Resident Project Representative and assistants.

ARTICLE 10--CHANGES IN THE WORK

10.1. Without invalidating the Agreement and without notice to any surety, OWNER may, at any time or from time to time, order additions, deletions or revisions in the Work. Such additions, deletions or revisions will be authorized by a Written Amendment, a Change Order, or a Work Change Directive. Upon receipt of any such document, CONTRACTOR shall promptly proceed with the Work involved which will be performed under the applicable conditions of the Contract Documents (except as otherwise specifically provided).

10.2. If OWNER and CONTRACTOR are unable to agree as to the extent, if any, of an adjustment in the Contract Price or an adjustment of the Contract Times that should be allowed as a result of a Work

Change Directive, a claim may be made therefore as provided in Article 11 or Article 12.

10.3. CONTRACTOR shall not be entitled to an increase in the Contract Price or an extension of the Contract Times with respect to any Work performed that is not required by the Contract Documents as amended, modified and supplemented as provided in paragraphs 3.5 and 3.6 except in the case of any emergency as provided in paragraph 6.23 or in the case of uncovering Work as provided in paragraph 13.9.

10.4. OWNER and CONTRACTOR shall execute appropriate Change Orders recommended by ENGINEER (or Written Amendments) covering:

10.4.1. changes in the Work which are (i) ordered by OWNER pursuant to paragraph 10.1, (ii) required because of acceptance of *defective* Work under paragraph 13.13 or correcting *defective* Work under paragraph 13.14, or (iii) agreed to by the parties;

10.4.2. changes in the Contract Price or Contract Times which are agreed to by the parties; and

10.4.3. changes in the Contract Price or Contract Times which embody the substance of any written decision rendered by ENGINEER pursuant to paragraph 9.11;

provided that, in lieu of executing any such Change Order, an appeal may be taken from any such decision in accordance with the provisions of the Contract Documents and applicable Laws and Regulations, but during any such appeal, CONTRACTOR shall carry on the Work and adhere to the progress schedule as provided in paragraph 6.29.

10.5. If notice of any change affecting the general scope of the Work or the provisions of the Contract Documents (including, but not limited to, Contract Price or Contract Times) is required by the provisions of any Bond to be given to a surety, the giving of any such notice will be CONTRACTOR's responsibility, and the amount of each applicable Bond will be adjusted accordingly.

ARTICLE 11--CHANGE OF CONTRACT PRICE

11.1. The Contract Price constitutes the total compensation (subject to authorized adjustments) payable to CONTRACTOR for performing the Work. All duties, responsibilities and obligations assigned to or undertaken by CONTRACTOR shall be at CONTRACTOR's expense without change in the Contract Price.

11.2. The Contract Price may only be changed by a Change Order or by a Written Amendment. Any claim for an adjustment in the Contract Price shall be based on written notice delivered by the party making the claim to the other party and to ENGINEER promptly (but in no event later than thirty days) after the start of the occurrence or event giving rise to the claim and stating the general nature of the claim. Notice of the amount of the claim with supporting data shall be delivered within sixty days after the start of such occurrence or event (unless ENGINEER allows additional time for claimant to submit additional or more accurate data in support of the claim) and shall be accompanied by claimant's written statement that the adjustment claimed covers all known amounts to which the claimant is entitled as a result of said occurrence or event. All claims for adjustment in the Contract Price shall be determined by ENGINEER in accordance with paragraph 9.11 if OWNER and CONTRACTOR cannot otherwise

agree on the amount involved. No claim for an adjustment in the Contract Price will be valid if not submitted in accordance with this paragraph 11.2.

11.3. The value of any Work covered by a Change Order or of any claim for an adjustment in the Contract Price will be determined as follows:

11.3.1. where the Work involved is covered by unit prices contained in the Contract Documents, by application of such unit prices to the quantities of the items involved (subject to the provisions of paragraphs 11.9.1 through 11.9.3, inclusive);

11.3.2. where the Work involved is not covered by unit prices contained in the Contract Documents, by a mutually agreed lump sum (which may include an allowance for overhead and profit not necessarily in accordance with paragraph 11.6.2);

11.3.3. where the Work involved is not covered by unit prices contained in the Contract Documents and agreement to a lump sum is not reached under paragraph 11.3.2, on the basis of the Cost of the Work (determined as provided in paragraphs 11.4 and 11.5) plus a CONTRACTOR's fee for overhead and profit (determined as provided in paragraph 11.6).

Cost of the Work:

11.4. The term Cost of the Work means the sum of all costs necessarily incurred and paid by Contractor in the proper performance of the Work. Except as otherwise may be agreed to in writing by OWNER, such costs shall be in amount no higher than those prevailing in the locality of the Project, shall include only the following items and shall not include any of the costs itemized in paragraph 11.5:

11.4.1. Payroll costs for employees in the direct employ of CONTRACTOR in the performance of the Work under schedules of job classifications agreed upon by OWNER and CONTRACTOR. Such employees shall include without limitation superintendents, foremen and other personnel employed full-time at the site. Payroll costs for employees not employed full time on the Work shall be apportioned on the basis of their time spent on the Work. Payroll costs shall include, but not be limited to, salaries and wages plus the cost of fringe benefits which shall include social security contributions, unemployment, excise and payroll taxes, workers' compensation, health and retirement benefits, bonuses, sick leave, vacation and holiday pay applicable thereto. The expenses of performing Work after regular working hours, on Saturday, Sunday or legal holidays, shall be included in the above to the extent authorized by OWNER.

11.4.2. Cost of all materials and equipment furnished and incorporated in the Work, including costs of transportation and storage thereof, and Suppliers' field services required in connection therewith. All cash discounts shall accrue to CONTRACTOR unless OWNER deposits funds with CONTRACTOR with which to make payments, in which case the cash discounts shall accrue to OWNER. All trade discounts, rebates and refunds and returns from sale of surplus materials and equipment shall accrue to OWNER, and CONTRACTOR shall make provisions so that they may be obtained.

11.4.3. Payments made by CONTRACTOR to the Subcontractors for Work performed or furnished by Subcontractors. If required by OWNER, CONTRACTOR shall

obtain competitive bids from subcontractors acceptable to OWNER and CONTRACTOR and shall deliver such bids to OWNER who will then determine, with the advice of ENGINEER, which bids, if any, will be accepted. If any subcontract provides that the Subcontractor is to be paid on the basis of Cost of the Work Plus a fee, the Subcontractor's Cost of the Work and fee shall be determined in the same manner as CONTRACTOR's Cost of the Work and fee as provided in paragraphs 11.4, 11.5, 11.6 and 11.7. All subcontracts shall be subject to the other provisions of the Contract Documents insofar as applicable.

11.4.4. Costs of special consultants (including but not limited to engineers, architects, testing laboratories, surveyors, attorneys and accountants) employed for services specifically related to the Work.

11.4.5. Supplemental costs including the following:

11.4.5.1. The proportion of necessary transportation, travel and subsistence expenses of CONTRACTOR's employees incurred in discharge of duties connected with the Work.

11.4.5.2. Cost, including transportation and maintenance, of all materials, supplies, equipment, machinery, appliances, office and temporary facilities at the site and hand tools not owned by the workers, which are consumed in the performance of the Work, and cost less market value of such items used but not consumed which remain the property of CONTRACTOR.

11.4.5.3. Rentals of all construction equipment and machinery and the parts thereof whether rented from CONTRACTOR or others in accordance with rental agreements approved by OWNER with the advice of ENGINEER, and the costs of transportation, loading, unloading, installation, dismantling and removal thereof--all in accordance with the terms of said rental agreements. The rental of any such equipment, machinery or parts shall cease when the use thereof is no longer necessary for the Work.

11.4.5.4. Sales, consumer, use or similar taxes related to the Work, and for which CONTRACTOR is liable, imposed by Laws and Regulations.

11.4.5.5. Deposits lost for causes other than negligence of CONTRACTOR, any Subcontractor or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable, and royalty payments and fees for permits and licenses.

11.4.5.6. Losses and damages (and related expenses) caused by damage to the Work, not compensated by insurance or otherwise, sustained by CONTRACTOR in connection with the performance and furnishing of the Work (except losses and damages within the deductible amounts of property insurance established by OWNER in accordance with paragraph 5.9), provided they have resulted from causes other than the negligence of CONTRACTOR, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable. Such losses shall include settlements made with the written consent and approval of OWNER. No such losses, damages and expenses shall be included in the Cost of the Work for the purpose of determining CONTRACTOR's fee. If, however, any such loss or damage requires reconstruction and CONTRACTOR is

placed in charge thereof, CONTRACTOR shall be paid for services a fee proportionate to that stated in paragraph 11.6.2.

11.4.5.7. The cost of utilities, fuel and sanitary facilities at the site.

11.4.5.8. Minor expenses such as telegrams, long distance telephone calls, telephone service at the site, expressage and similar petty cash items in connection with the Work.

11.4.5.9. Cost of premiums for additional Bonds and insurance required because of changes in the Work.

11.5. The term Cost of the Work shall not include any of the following:

11.5.1. Payroll costs and other compensation of CONTRACTOR's officers, executives, principals (of partnership and sole proprietorships), general managers, engineers, architects, estimators, attorneys, auditors, accountants, purchasing and contracting agents, expeditors, timekeepers, clerks and other personnel employed by CONTRACTOR whether at the site or in CONTRACTOR's principal or a branch office for general administration of the Work and not specifically included in the agreed upon schedule of job classifications referred to in paragraph 11.4.1. or specifically covered by paragraph 11.4.4--all of which are to be considered administrative costs covered by the CONTRACTOR's fee.

11.5.2. Expenses of CONTRACTOR's principal and branch offices other than CONTRACTOR's office at the site.

11.5.3. Any part of CONTRACTOR's capital expenses, including interest on CONTRACTOR's capital employed for the Work and charges against CONTRACTOR for delinquent payments.

11.5.4. Cost of premiums for all Bonds and for all insurance whether or not CONTRACTOR is required by the Contract Documents to purchase and maintain the same (except for the cost of premiums covered by subparagraph 11.4.5.9 above).

11.5.5. Costs due to the negligence of CONTRACTOR, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable, including but not limited to, the correction of *defective* Work, disposal of materials or equipment wrongly supplied and making good any damage to property.

Other overhead or general expense costs of any kind and the costs of any item not specifically and expressly included in paragraph 11.4.

11.6. The CONTRACTOR's fee allowed to CONTRACTOR for overhead and profit shall be determined as follows:

11.6.1. a mutually acceptable fixed fee

11.7. Whenever the cost of any Work is to be determined pursuant to paragraphs 11.4 and 11.5, CONTRACTOR will establish and maintain records thereof in accordance with generally accepted accounting practices and submit in form acceptable to ENGINEER an itemized cost breakdown together with supporting data.

Cash Allowance:

11.8. It is understood that CONTRACTOR has included in the Contract Price all allowances so named in the Contract Documents and shall cause the Work so covered to be furnished and performed for such sums as may be acceptable to OWNER and ENGINEER. CONTRACTOR agrees that:

11.8.1. the allowances include the cost to CONTRACTOR (less any applicable trade discounts) of materials and equipment required by the allowances to be delivered at the site, and all applicable taxes; and

11.8.2. CONTRACTOR's cost for unloading and handling on the site, labor, installation costs, overhead, profit and other expenses contemplated for the allowances have been included in the Contract Price and not in the allowances and no demand for additional payment on account of any of the foregoing will be valid.

Prior to final payment, an appropriate Change Order will be issued as recommended by ENGINEER to reflect actual amounts due CONTRACTOR on account of Work covered by allowances, and the Contract Price shall be correspondingly adjusted.

11.9. Unit Price Work:

11.9.1. Where the Contract Documents provide that all or part of the Work is to be Unit Price Work, initially the Contract Price will be deemed to include for all Unit Price Work an amount equal to the sum of the established unit price for each separately identified item of Unit Price Work times the estimated quantity of each item as indicated in the Agreement. The estimated quantities of items of Unit Price Work are not guaranteed and are solely for the purpose of comparison of Bids and determining an initial Contract Price. Determinations of the actual quantities and classifications of Unit Price Work performed by CONTRACTOR will be made by ENGINEER in accordance with paragraph 9.10.

11.9.2. Each unit price will be deemed to include an amount considered by CONTRACTOR to be adequate to cover CONTRACTOR's overhead and profit for each separately identified item.

11.9.3. OWNER or CONTRACTOR may make a claim for an adjustment in the Contract Price in accordance with Article 11 if:

11.9.3.1. the quantity of any item of Unit Price Work performed by CONTRACTOR differs materially and significantly from the estimated quantity of such item indicated in the Agreement; and

11.9.3.2. there is no corresponding adjustment with respect to any other item of Work; and

11.9.3.3. if CONTRACTOR believes that CONTRACTOR is entitled to an increase in Contract Price as a result of having incurred additional expense or OWNER believes that OWNER is entitled to a decrease in Contract Price and the parties are unable to agree as to the amount of any such increase or decrease.

ARTICLE 12--CHANGE OF CONTRACT TIMES

12.1. The Contract Times (or Milestones) may only be changed by a Change Order or a Written Amendment. Any claim for an adjustment of the Contract Times (or Milestones) shall be based on written notice delivered by the party making the claim to the other party and to ENGINEER promptly (but in no event later than thirty days) after the occurrence of the event giving rise to the claim and stating the general nature of the claim. Notice of the extent of the claim with supporting data shall be delivered within sixty days after such occurrence (unless ENGINEER allows an additional period of time to ascertain more accurate data in support of the claim) and shall be accompanied by the claimant's written statement that the adjustment claimed is the entire adjustment to which the claimant has reason to believe it is entitled as a result of the occurrence of said event. All claims for adjustment in the Contract Times (or Milestones) shall be determined by ENGINEER in accordance with paragraph 9.11 if OWNER and CONTRACTOR cannot otherwise agree. No claim for an adjustment in the Contract Times (or Milestones) will be valid if not submitted in accordance with the requirements of this paragraph 12.1.

12.2. All time limits stated in the Contract Documents are of the essence of the Agreement.

12.3. Where CONTRACTOR is prevented from completing any part of the Work within the Contract Times (or Milestones) due to delay beyond the control of CONTRACTOR, the Contract Times (or Milestones) will be extended in an amount equal to the time lost due to such delay if a claim is made therefore as provided in paragraph 12.1. Delays beyond the control of CONTRACTOR shall include, but not be limited to, acts or neglect by OWNER, acts or neglect of utility owners or other contractors performing other work as contemplated by Article 7, fires, floods, epidemics, abnormal weather conditions or acts of God. Delays attributable to and within the control of a Subcontractor or Supplier shall be deemed to be delays within the control of CONTRACTOR.

12.4. Where CONTRACTOR is prevented from completing any part of the Work within the Contract Times (or Milestones) due to delay beyond the control of both OWNER and CONTRACTOR, an extension of the Contract Times (or Milestones) in an amount equal to the time lost due to such delay shall be CONTRACTOR's sole and exclusive remedy for such delay. In no event shall OWNER be liable to CONTRACTOR, any Subcontractor, any Supplier, any other person or organization, or to any surety for or employee or agent of any of them, for damages arising out of or resulting from (i) delays caused by or within the control of CONTRACTOR, or (ii) delays beyond the control of both parties including but not limited to fires, floods,

epidemics, abnormal weather conditions, acts of God or acts or neglect by utility owners or other contractors performing other work as contemplated by Article 7.

ARTICLE 13--TESTS AND INSPECTIONS; CORRECTION, REMOVAL OR ACCEPTANCE OF DEFECTIVE WORK

13.1. *Notice of Defects:* Prompt notice of all *defective* Work of which OWNER or ENGINEER have actual knowledge will be given to CONTRACTOR. All *defective* Work may be rejected, corrected or accepted as provided in this Article 13.

Access to Work:

13.2. OWNER, ENGINEER, ENGINEER's Consultants, other representatives and personnel of OWNER, independent testing laboratories and governmental agencies with jurisdiction interests will have access to the Work at reasonable times for their observation, inspecting and testing. CONTRACTOR shall provide them proper and safe conditions for such access and advise them of CONTRACTOR's site safety procedures and programs so that they may comply therewith as applicable.

Tests and Inspections:

13.3. CONTRACTOR shall give ENGINEER timely notice of readiness of the Work for all required inspections, tests or approvals, and shall cooperate with inspection and testing personnel to facilitate required inspections or tests.

13.4. OWNER shall employ and pay for the services of an independent testing laboratory to perform all inspections, tests, or approvals required by the Contract Documents except:

13.4.1. for inspections, tests or approvals covered by paragraph 13.5 below;

13.4.2. that costs incurred in connection with tests or inspections conducted pursuant to paragraph 13.9 below shall be paid as provided in said paragraph 13.9; and

13.4.3. as otherwise specifically provided in the Contract Documents.

13.5. If Laws or Regulations of any public body having jurisdiction require any Work (or part thereof) specifically to be inspected, tested or approved by an employee or other representative of such public body, CONTRACTOR shall assume full responsibility for arranging and obtaining such inspections, tests or approvals, pay all costs in connection therewith, and furnish ENGINEER the required certificates of inspection, or approval. CONTRACTOR shall also be responsible for arranging and obtaining and shall pay all costs in connection with any inspections, tests or approvals required for OWNER's and ENGINEER's acceptance of materials or equipment to be incorporated in the Work, or of materials, mix designs, or equipment submitted for approval prior to CONTRACTOR's purchase thereof for incorporation in the Work.

13.6. If any Work (or the work of others) that is to be inspected, tested or approved is covered by CONTRACTOR without written concurrence of ENGINEER, it must, if requested by ENGINEER, be uncovered for observation.

13.7. Uncovering Work as provided in paragraph 13.6 shall be at CONTRACTOR's expense unless CONTRACTOR has given ENGINEER timely notice of CONTRACTOR's intention to cover the same and ENGINEER has not acted with reasonable promptness in response to such notice.

Uncovering Work:

13.8. If any Work is covered contrary to the written request of ENGINEER, it must, if requested by ENGINEER, be uncovered for ENGINEER's observation and replaced at CONTRACTOR's expense.

13.9. If ENGINEER considers it necessary or advisable that covered Work be observed by ENGINEER or inspected or tested by others, CONTRACTOR, at ENGINEER's request, shall uncover, expose or otherwise make available for observation, inspection or testing as ENGINEER may require, that portion of the Work in question, furnishing all necessary labor, material and equipment. If it is found that such Work is *defective*, CONTRACTOR shall pay all claims, costs, losses and damages caused by, arising out of or resulting from such uncovering, exposure, observation, inspection and testing and of satisfactory replacement or reconstruction (including but not limited to all costs of repair or replacement of work of others); and OWNER shall be entitled to an appropriate decrease in the Contract Price, and, if the parties are unable to agree as to the amount thereof, may make a claim therefore as provided in Article 11. If, however, such Work is not found to be *defective*, CONTRACTOR shall be allowed an increase in the Contract Price or an extension of the Contract Times (or Milestones), or both, directly attributable to such uncovering, exposure, observation, inspection, testing, replacement and reconstruction; and, if the parties are unable to agree as to the amount or extent thereof, CONTRACTOR may make a claim therefore as provided in Articles 11 and 12.

OWNER May Stop the Work:

13.10. If the Work is *defective*, or CONTRACTOR fails to supply sufficient skilled workers or suitable materials or equipment, or fails to furnish or perform the Work in such a way that the completed Work will conform to the Contract Documents, OWNER may order CONTRACTOR to stop the Work, or any portion thereof, until the cause for such order has been eliminated; however, this right of OWNER to stop the Work shall not give rise to any duty on the part of OWNER to exercise this right for the benefit of CONTRACTOR or any surety or other party.

Correction or Removal of Defective Work:

13.11. If required by ENGINEER, CONTRACTOR shall promptly, as directed, either correct all *defective* Work, whether or not fabricated, installed or completed, or, if the Work has been rejected by ENGINEER, remove it from the site and replace it with Work that is not *defective*. CONTRACTOR shall pay all claims, costs, losses and damages caused by or resulting from such correction or removal (including but not limited to all costs of repair or replacement of work of others).

13.12. Correction Period:

13.12.1. If within one year after the date of Substantial Completion or such longer period of time as may be prescribed by Laws or Regulations or by the terms of any applicable special guarantee required by the Contract Documents or by any specific provision of the Contract Documents, any Work is found to be *defective*, CONTRACTOR shall promptly, without cost to

OWNER and in accordance with OWNER's written instructions: (i) correct such *defective* Work, or, if it has been rejected by OWNER, remove it from the site and replace it with Work that is not *defective*, and (ii) satisfactorily correct or remove and replace any damage to other Work or the work of others resulting therefrom. If CONTRACTOR does not promptly comply with the terms of such instructions, or in an emergency where delay would cause serious risk of loss or damage, OWNER may have the *defective* Work corrected or the rejected Work removed and replaced, and all claims, costs, losses and damages caused by or resulting from such removal and replacement (including but not limited to all costs of repair or replacement of work of others) will be paid by CONTRACTOR.

13.12.2. In special circumstances where a particular item of equipment is placed in continuous service before Substantial Completion of all the Work, the correction period for that item may start to run from an earlier date if so provided in the Specifications or by Written Amendment.

13.12.3. Where *defective* Work (and damage to other Work resulting therefrom) has been corrected, removed or replaced under this paragraph 13.12, the correction period hereunder with respect to such Work will be extended for an additional period of one year after such correction or removal and replacement has been satisfactorily completed.

Acceptance of Defective Work:

13.13. If, instead of requiring correction or removal and replacement of *defective* Work OWNER (and, prior to ENGINEER's recommendation of final payment, also ENGINEER) prefers to accept it, OWNER may do so. CONTRACTOR shall pay all claims, costs, losses and damages attributable to OWNER's evaluation of and determination to accept such *defective* Work (such costs to be approved by ENGINEER as to reasonableness). If any such acceptance occurs prior to ENGINEER's recommendation of final payment, a Change Order will be issued incorporating the necessary revisions in the Contract Documents with respect to the Work; and OWNER shall be entitled to an appropriate decrease in the Contract Price, and, if the parties are unable to agree as to the amount thereof, OWNER may make a claim therefore as provided in Article 11. If the acceptance occurs after such recommendation, an appropriate amount will be paid by CONTRACTOR to OWNER.

OWNER May Correct Defective Work:

13.14. If CONTRACTOR fails within a reasonable time after written notice from ENGINEER to correct *defective* Work or to remove and replace rejected Work as required by ENGINEER in accordance with paragraph 13.11, or if CONTRACTOR fails to perform the Work in accordance with the Contract Documents, or if CONTRACTOR fails to comply with any other provision of the Contract Documents, OWNER may, after seven days' written notice to CONTRACTOR, correct and remedy any such deficiency. In exercising the rights and remedies under this paragraph OWNER shall proceed expeditiously. In connection with such corrective and remedial action, OWNER may exclude CONTRACTOR from all or part of the site, take possession of all or part of the Work, and suspend CONTRACTOR's services related thereto, take possession of CONTRACTOR's tools, appliances, construction equipment and machinery at the site and incorporate in the Work all materials and equipment stored at the site or for which OWNER has paid CONTRACTOR but which are stored elsewhere. CONTRACTOR shall allow OWNER, OWNER's representatives, agents and employees, OWNER's other contractors and ENGINEER and ENGINEER's Consultants access to the site to enable OWNER to

exercise the rights and remedies under this paragraph. All claims, costs, losses and damages incurred or sustained by OWNER in exercising such rights and remedies will be charged against CONTRACTOR and a Change Order will be issued incorporating the necessary revisions in the Contract Documents with respect to the Work; and OWNER shall be entitled to an appropriate decrease in the Contract Price, and, if the parties are unable to agree as to the amount thereof, OWNER may make a claim therefore as provided in Article 11. Such claims, costs, losses and damages will include but not be limited to all costs of repair or replacement of work of others destroyed or damaged by correction, removal or replacement of CONTRACTOR's *defective* Work. CONTRACTOR shall not be allowed an extension of the Contract Times (or Milestones) because of any delay in the performance of the Work attributable to the exercise by OWNER of OWNER's rights and remedies hereunder.

ARTICLE 14--PAYMENTS TO CONTRACTOR AND COMPLETION

Schedule of Values:

14.1. The schedule of values established as provided in paragraph 2.9 will serve as the basis for progress payments and will be incorporated into a form of Application for Payment acceptable to ENGINEER. Progress payments on account of Unit Price Work will be based on the number of units completed.

Application for Progress Payment

14.2. At least twenty days before the date established for each progress payment (but not more often than once a month), CONTRACTOR shall submit to ENGINEER for review an Application for Payment filled out and signed by CONTRACTOR covering the Work completed as of the date of the Application and accompanied by such supporting documentation as is required by the Contract Documents. If payment is requested on the basis of materials and equipment not incorporated in the Work but delivered and suitably stored at the site or at another location agreed to in writing, the Application for Payment shall also be accompanied by a bill of sale, invoice or other documentation warranting that OWNER has received the materials and equipment free and clear of all Liens and evidence that the materials and equipment are covered by appropriate property insurance and other arrangements to protect OWNER's interest therein, all of which will be satisfactory to OWNER. The amount of retainage with respect to progress payments will be as stipulated in the Agreement.

CONTRACTOR's Warranty of Title:

14.3. CONTRACTOR warrants and guarantees that title to all Work, materials and equipment covered by any Application for Payment, whether incorporated in the Project or not, will pass to OWNER no later than the time of payment free and clear of all Liens.

Review of Applications for Progress Payment:

14.5. ENGINEER's recommendation of any payment requested in an Application for Payment will constitute a representation by ENGINEER to OWNER, based on ENGINEER's on-site observations of the executed Work as an experienced and qualified design professional and on ENGINEER's review of the Application for Payment and the accompanying data and schedules, that to the best of ENGINEER's knowledge, information and belief:

14.5.1. the Work has progressed to the point indicated.

14.5.2. the quality of the Work is generally in accordance with the Contract Documents (subject to an evaluation of the Work as a functioning whole prior to or upon Substantial Completion, to the results of any subsequent tests called for in the Contract Documents, to a final determination of quantities and classifications for Unit Price Work under paragraph 9.10, and to any other qualifications stated in the recommendation), and

14.5.3. the conditions precedent to CONTRACTOR's being entitled to such payment appear to have been fulfilled in so far as it is ENGINEER's responsibility to observe the Work.

However, by recommending any such payment ENGINEER will not thereby be deemed to have represented that: (i) exhaustive or continuous on-site inspections have been made to check the quality or the quantity of the Work beyond the responsibilities specifically assigned to ENGINEER in the Contract Documents or (ii) that there may not be other matters or issues between the parties that might entitle CONTRACTOR to be paid additionally by OWNER or entitle OWNER to withhold payment to CONTRACTOR.

14.6. ENGINEER's recommendation of any payment, including final payment, shall not mean that ENGINEER is responsible for CONTRACTOR's means, methods, techniques, sequences or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of CONTRACTOR to comply with Laws and Regulations applicable to the furnishing or performance of Work, or for any failure of CONTRACTOR to perform or furnish Work in accordance with the Contract Documents.

14.7. ENGINEER may refuse to recommend the whole or any part of any payment if, in ENGINEER's opinion, it would be incorrect to make the representations to OWNER referred to in paragraph 14.5. ENGINEER may also refuse to recommend any such payment, or, because of subsequently discovered evidence or the results of subsequent inspections or tests, nullify any such payment previously recommended, to such extent as may be necessary in ENGINEER's opinion to protect OWNER from loss because:

14.7.1. the Work is *defective*, or completed Work has been damaged requiring correction or replacement,

14.7.2. the Contract Price has been reduced by Written Amendment or Change Order,

14.7.3. OWNER has been required to correct *defective* Work or complete Work in accordance with paragraph 13.14, or

14.7.4. ENGINEER has actual knowledge of the occurrence of any of the events enumerated in paragraphs 15.2.1 through 15.2.4 inclusive.

OWNER may refuse to make payment of the full amount recommended by ENGINEER because:

14.7.5. claims have been made against OWNER on account of CONTRACTOR's performance or furnishing of the Work,

14.7.6. Liens have been filed in connection with the Work, except where CONTRACTOR has delivered a specific Bond satisfactory to OWNER to secure the satisfaction and discharge of such Liens.

14.7.7. there are other items entitling OWNER to a set-off against the amount recommended, or

14.7.8. OWNER has actual knowledge of the occurrence of any of the events enumerated in paragraphs 14.7.1. through 14.7.3 or paragraphs 15.2.1 through 15.2.4 inclusive;

but OWNER must have CONTRACTOR immediate written notice (with a copy to ENGINEER) stating the reasons for such action and promptly pay CONTRACTOR the amount so withheld, or any adjustment thereto agreed to by OWNER and CONTRACTOR, when CONTRACTOR corrects to OWNER's satisfaction the reasons for such action.

Substantial Completion:

14.8. When CONTRACTOR considers the entire Work ready for its intended use CONTRACTOR shall notify OWNER and ENGINEER in writing that the entire Work is substantially complete (except for items specifically listed by CONTRACTOR as incomplete) and request that ENGINEER issue a certificate of Substantial Completion. Within a reasonable time thereafter, OWNER, CONTRACTOR and ENGINEER shall make an inspection of the Work to determine the status of completion. If ENGINEER does not consider the Work substantially complete, ENGINEER will notify CONTRACTOR in writing giving the reasons therefore. If ENGINEER considers the Work substantially complete, ENGINEER will prepare and deliver to OWNER a tentative certificate of Substantial Completion which shall fix the date of Substantial Completion. There shall be attached to the certificate a tentative list of items to be completed or corrected before final payment. OWNER shall have seven days after receipt of the tentative certificate during which to make written objection to ENGINEER as to any provisions of the certificate or attached list. If, after considering such objections, ENGINEER concludes that the Work is not substantially complete, ENGINEER will within fourteen days after submission of the tentative certificate to OWNER notify CONTRACTOR in writing, stating the reasons therefore. If, after consideration of OWNER's objections, ENGINEER considers the Work substantially complete, ENGINEER will within said fourteen days execute and deliver to OWNER and CONTRACTOR a definitive certificate of Substantial Completion (with a revised tentative list of items to be completed or corrected) reflecting such changes from the tentative certificate as ENGINEER believes justified after consideration of any objections from OWNER. At the time of delivery of the tentative certificate of Substantial Completion ENGINEER will deliver to OWNER and CONTRACTOR a written recommendation as to division of responsibilities pending final payment between OWNER

and CONTRACTOR with respect to security, operation, safety, maintenance, heat, utilities, insurance and warranties and guarantees. Unless OWNER and CONTRACTOR agree otherwise in writing and so inform ENGINEER in writing prior to ENGINEER's issuing the definitive certificate of Substantial Completion, ENGINEER's aforesaid recommendation will be binding on OWNER and CONTRACTOR until final payment.

14.9. OWNER shall have the right to exclude CONTRACTOR from the Work after the date of Substantial Completion, but OWNER shall allow CONTRACTOR reasonable access to complete or correct items on the tentative list.

Partial Utilization:

14.10. Use by OWNER at OWNER's option of any substantially completed part of the Work which: (i) has specifically been identified in the Contract Documents, or (ii) OWNER, ENGINEER and CONTRACTOR agree constitutes a separately functioning and usable part of the Work that can be used by OWNER for its intended purpose without significant interference with CONTRACTOR's performance of the remainder of the Work, may be accomplished prior to Substantial Completion of all the Work subject to the following:

14.10.1. OWNER at any time may request CONTRACTOR in writing to permit OWNER to use any such part of the Work which OWNER believes to be ready for its intended use and substantially complete. If CONTRACTOR agrees that such part of the Work is substantially complete, CONTRACTOR will certify to OWNER and ENGINEER that such part of the Work is substantially complete and request ENGINEER to issue a certificate of Substantial Completion for that part of the Work. CONTRACTOR at any time may notify OWNER and ENGINEER in writing that CONTRACTOR considers any such part of the Work ready for its intended use and substantially complete and request ENGINEER to issue a certificate of Substantial Completion for that part of the Work. Within a reasonable time after either such request, OWNER, CONTRACTOR and ENGINEER shall make an inspection of that part of the Work to determine its status of completion. If ENGINEER does not consider that part of the Work to be substantially complete, ENGINEER will notify OWNER and CONTRACTOR in writing giving the reasons therefore. If ENGINEER considers that part of the Work to be substantially complete, the provisions of paragraphs 14.8 and 14.9 will apply with respect to certification of Substantial Completion of that part of the Work and the division of responsibility in respect thereof and access thereto.

14.10.2. No occupancy or separate operation of part of the Work will be accomplished prior to compliance with the requirements of paragraph 5.15 in respect of property insurance.

Final Inspection:

14.11. Upon written notice from CONTRACTOR that the entire Work or an agreed portion thereof is complete, ENGINEER will make a final inspection with OWNER and CONTRACTOR and will notify CONTRACTOR in writing of all particulars in which this inspection reveals that the Work is incomplete or *defective*. CONTRACTOR shall immediately take such measures as are necessary to complete such Work or remedy such deficiencies.

Final Application for Payment:

14.12. After CONTRACTOR has completed all such corrections to the satisfaction of ENGINEER and delivered in accordance with the Contract Documents all maintenance and operating instructions, schedules, guarantees, Bonds, certificates or other evidence of insurance required by paragraph 5.4, certificates of inspection, marked-up record documents (as provided in paragraph 6.19) and other documents, CONTRACTOR may make application for final payment following the procedure for progress payments. The final Application for Payment shall be accompanied (except as previously delivered) by: (i) all documentation called for in the Contract Documents, including but not limited to the evidence of insurance required by subparagraph 5.4.13, (ii) consent of the surety, if any, to final payment, and (iii) complete and legally effective releases or waivers (satisfactory to OWNER) of all Liens arising out of or filed in connection with the Work. In lieu of such releases or waivers of Liens and as approved by OWNER, CONTRACTOR may furnish receipts or releases in full and an affidavit of CONTRACTOR that: (i) the releases and receipts include all labor, services, material and equipment for which a Lien could be filed, and (ii) all payrolls, material and equipment bills and other indebtedness connected with the Work for which OWNER or OWNER's property might in any way be responsible have been paid or otherwise satisfied. If any Subcontractor or Supplier fails to furnish such a release or receipt in full, CONTRACTOR may furnish a Bond or other collateral satisfactory to OWNER to indemnify OWNER against any Lien.

Final Payment and Acceptance:

14.13. If, on the basis of ENGINEER's observation of the Work during construction and final inspection, and ENGINEER's review of the final Application for Payment and accompanying documentation as required by the Contract Documents, ENGINEER is satisfied that the Work has been completed and CONTRACTOR's other obligations under the Contract Documents have been fulfilled, ENGINEER will, within ten days after receipt of the final Application for Payment, indicate in writing ENGINEER's recommendation of payment and present the Application to OWNER for payment. At the same time ENGINEER will also give written notice to OWNER and CONTRACTOR that the Work is acceptable subject to the provisions of paragraph 14.15. Otherwise, ENGINEER will return the Application to CONTRACTOR, indicating in writing the reasons for refusing to recommend final payment, in which case CONTRACTOR shall make the necessary corrections and resubmit the Application.

14.14. If, through no fault of CONTRACTOR, final completion of the Work is significantly delayed and if ENGINEER so confirms, OWNER shall, upon receipt of CONTRACTOR's final Application for Payment and recommendation of ENGINEER, and without terminating the Agreement, make payment of the balance due for that portion of the Work fully completed and accepted. If the remaining balance to be held by OWNER for Work not fully completed or corrected is less than the retainage stipulated in the Agreement, and if Bonds have been furnished as required in paragraph 5.1, the written consent of the surety to the payment of the balance due for that portion of the Work fully completed and accepted shall be submitted by CONTRACTOR to ENGINEER with the Application for such payment. Such payment shall be made under the terms and conditions governing final payment, except that it shall not constitute a waiver of claims.

Waiver of Claims:

14.15. The making and acceptance of final payment will constitute:

14.15.1. a waiver of all claims by OWNER against CONTRACTOR, except claims arising from unsettled Liens, from defective Work appearing after final inspection pursuant to

paragraph 14.11, from failure to comply with the Contract Documents or the terms of any special guarantees specified therein, or from CONTRACTOR's continuing obligations under the Contract Documents; and

14.15.2. a waiver of all claims by CONTRACTOR against OWNER other than those previously made in writing and still unsettled.

ARTICLE 15--SUSPENSION OF WORK AND TERMINATION

OWNER May Suspend Work:

15.1. At any time and without cause, OWNER may suspend the Work, or any portion thereof for a period of not more than ninety days by notice in writing to CONTRACTOR and ENGINEER which will fix the date on which Work will be resumed. CONTRACTOR shall resume the Work on the date so fixed. CONTRACTOR shall be allowed an adjustment in the Contract Price or an extension of the Contract Times, or both, directly attributable to any such suspension if CONTRACTOR makes an approved claim therefore as provided in Articles 11 and 12.

OWNER May Terminate:

15.2. Upon the occurrence of any one or more of the following events:

15.2.1. if CONTRACTOR persistently fails to perform the Work in accordance with the Contract Documents (including, but not limited to, failure to supply sufficient skilled workers or suitable materials or equipment or failure to adhere to the progress schedule established under paragraph 2.9 as adjusted from time to time pursuant to paragraph 6.6);

15.2.2. if CONTRACTOR disregards Laws or Regulations of any public body having jurisdiction;

15.2.3. if CONTRACTOR disregards the authority of ENGINEER; or

15.2.4. if CONTRACTOR otherwise violates in any substantial way any provisions of the Contract Documents;

OWNER may, after giving CONTRACTOR (and the surety, if any,) seven days' written notice and to the extent permitted by Laws and Regulations, terminate the services of CONTRACTOR, exclude CONTRACTOR from the site and take possession of the Work and of all CONTRACTOR's tools, appliances, construction equipment and machinery at the site and use the same to the full extent they could be used by CONTRACTOR (without liability to CONTRACTOR for trespass or conversion), incorporate in the Work all materials and equipment stored at the site or for which Owner has paid CONTRACTOR but which are stored elsewhere, and finish the Work as OWNER may deem expedient. In such case CONTRACTOR shall not be entitled to receive any further payment until the Work is finished. If the unpaid balance of the Contract Price exceeds all claims, costs, losses and damages sustained by OWNER arising out of or resulting from completing the Work such excess will be paid to CONTRACTOR. If such claims, costs, losses and damages exceed such unpaid balance, CONTRACTOR shall pay the difference to OWNER. Such claims, costs, losses and damages incurred by

OWNER will be reviewed by ENGINEER as to their reasonableness and when so approved by ENGINEER incorporated in a Change Order, provided that when exercising any rights or remedies under this paragraph OWNER shall not be required to obtain the lowest price for the Work performed.

15.3. Where CONTRACTOR's services have been so terminated by OWNER, the termination will not affect any rights or remedies of OWNER against CONTRACTOR then existing or which may thereafter accrue. Any retention or payment of monies due CONTRACTOR by OWNER will not release CONTRACTOR from liability.

15.4. Upon seven day's written notice to CONTRACTOR and ENGINEER, OWNER may, without cause and without prejudice to any other right or remedy of OWNER, elect to terminate the Agreement. In such case, CONTRACTOR shall be paid (without duplication of any items);

15.4.1. for completed and acceptable Work executed in accordance with the Contract Documents prior to the effective date of termination, including fair and reasonable sums for overhead and profit on such Work;

15.4.2. for expenses sustained prior to the effective date of termination in performing services and furnishing labor, materials or equipment as required by the Contract Documents in connection with uncompleted Work, plus fair and reasonable sums for overhead and profit on such expenses;

15.4.3. for all claims, costs, losses and damages incurred in settlement of terminated contracts with Subcontractors, Suppliers and others; and

15.4.4. for reasonable expenses directly attributable to termination.

CONTRACTOR shall not be paid on account of loss of anticipated profits or revenue or other economic loss arising out of or resulting from such termination.

CONTRACTOR May Stop Work or Terminate:

15.5. If, through no act or fault of CONTRACTOR, the Work is suspended for a period of more than ninety days by OWNER or under an order of court or other public authority, or ENGINEER fails to act on any Application of Payment within thirty days after it is submitted or OWNER fails for thirty days to pay CONTRACTOR any sum finally determined to be due, then CONTRACTOR may, upon seven days' written notice to OWNER and ENGINEER, and provided OWNER and ENGINEER do not remedy such suspension or failure within that time, terminate the Agreement and recover from OWNER payment on the same terms as provided in paragraph 15.4. In lieu of terminating the Agreement and without prejudice to any other right or remedy, if ENGINEER has failed to act on an Application for Payment within thirty days after it is submitted, or OWNER has failed for thirty days to pay CONTRACTOR any sum finally determined to be due, CONTRACTOR may upon seven day's written notice to OWNER and ENGINEER stop the Work until payment of all such amount due CONTRACTOR, including interest thereon. The provisions of this paragraph 15.5 are not intended to preclude CONTRACTOR from making claim under Articles 11 and 12 for an increase in Contract Price or Contract Times or otherwise for expenses or damage directly attributable to CONTRACTOR's stopping Work as permitted by this paragraph.

ARTICLE 16--DISPUTE RESOLUTION

If and to the extent that OWNER and CONTRACTOR have agreed on the method and procedure for resolving disputes between them that may arise under this Agreement, such dispute resolution method and procedure, if any, shall be as set forth in Exhibit GC-A, "Dispute Resolution Agreement," to be attached hereto and made a part hereof. If no such agreement on the method and procedure for resolving such disputes has been reached, and subject to the provisions of paragraphs 9.10, 9.11, and 9.12, OWNER and CONTRACTOR may exercise such rights or remedies as either may otherwise have under the Contract Documents or by Laws or Regulations in respect of any dispute.

ARTICLE 17--MISCELLANEOUS

Giving Notice:

17.1. Whenever any provision of the Contract Documents requires the giving of written notice, it will be deemed to have been validly given if delivered in person to the individual or to a member of the firm or to an officer of the corporation for whom it is intended, or if delivered at or sent by registered or certified mail, postage prepaid, to the last business address known to the giver of the notice.

Computation of Times:

17.2.1. When any period of time is referred to in the Contract Documents by days, it will be computed to exclude the first and include the last day of such period. If the last day of any such period falls on a Saturday or Sunday or on a day made a legal holiday by the law of the applicable jurisdiction, such day will be omitted from the computation.

17.2.2. A calendar day of twenty-four hours measured from midnight to the next midnight will constitute a day.

Notice of Claim:

17.3. Should OWNER or CONTRACTOR suffer injury or damage to person or property because of any error, omission or act of the other party or of any of the other party's employees or agents or others for whose acts the other party is legally liable, claim will be made in writing to the other party within a reasonable time of the first observance of such injury or damage. The provisions of this paragraph 17.3 shall not be construed as a substitute for or a waiver of the provisions of any applicable statute of limitations or repose.

Cumulative Remedies:

17.4. The duties and obligations imposed by these General Conditions and the rights and remedies available hereunder to the parties hereto, and, in particular but without limitation, the warranties, guarantees and obligations imposed upon CONTRACTOR by paragraphs 6.12, 6.16, 6.30, 6.31, 6.32, 13.1, 13.12, 13.14, 14.3 and 15.2 and all of the rights and remedies available to OWNER and ENGINEER thereunder, are in addition to, and are not to be construed in any way as a limitation of, any rights and remedies available to any or all of them which are otherwise imposed or available by Laws or Regulations, by special warranty or guarantee or by other provisions of the Contract Documents, and the provisions of this paragraph will be as effective as if repeated specifically in the Contract Documents in connection with each particular duty, obligation, right and remedy to which they apply.

Professional Fees and Court Costs Included:

17.5. Whenever reference is made to "claims, costs, losses and damages," it shall include in each case, but not be limited to, all fees and charges of engineers, architects, attorneys and other professionals and all court or arbitration or other dispute resolution costs.

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1. ENUMERATION OF PLANS, SPECIFICATIONS AND ADDENDA

Following are the Plans, Specifications and Addenda which form a part of this contract, as set forth in Paragraph 1 of the General Conditions, "Contract and Contract Documents":

DRAWINGS

General Construction:	Nos.	_____
Heating and Ventilating:	"	_____
Plumbing:	"	_____
Electrical:	"	_____
_____	"	_____
_____	"	_____

SPECIFICATIONS:

General Construction	Page _____ to _____, incl.
	Page _____ to _____, incl.
Heating and Ventilating:	Page _____ to _____, incl.
Plumbing:	Page _____ to _____, incl.
Electrical:	Page _____ to _____, incl.
_____	Page _____ to _____, incl.
_____	Page _____ to _____, incl.

ADDENDA:

No. _____	Date _____	No. _____	Date _____
No. _____	Date _____	No. _____	Date _____

2. STATED ALLOWANCES

Pursuant to Article 11.8 of the General Conditions, the Contractor shall include the following cash allowances in his proposal:

- (a) For _____ (Page _____ of Specifications) \$ _____
- (b) For _____ (Page _____ of Specifications) \$ _____
- (c) For _____ (Page _____ of Specifications) \$ _____
- (d) For _____ (Page _____ of Specifications) \$ _____
- (e) For _____ (Page _____ of Specifications) \$ _____
- (f) For _____ (Page _____ of Specifications) \$ _____

3. A. Payments to Contractor

1. To insure the proper performance of this contract, the Owner shall retain five percent (5%) of the amount of each estimate until final completion and acceptance of all work covered by this contract: Provided that the Contractor shall submit his estimate not later than the first day of the month: Provided further that on completion and acceptance of each separate building, public work, or other division of the contract, on which the price is stated separately in the contract, payment may be made in full, including retained percentages thereon, less authorized deductions.
2. In preparing estimates the material delivered on the site and preparatory work done may be taken into consideration.
3. All material and work covered by partial payments made shall thereupon become the sole property of the Owner, but this provision shall not be construed as relieving the Contractor from the sole responsibility for the care and protection of materials and work upon which payments have been made or the restoration of any damaged work, or as a waiver of the right of the Owner to require the fulfillment of all of the terms of the contract.
4. Owner's Right to Withhold Certain Amounts and Make Application Thereof: The Contractor agrees that he will indemnify and save the Owner harmless from all claims growing out of the lawful demands of subcontractors, laborers, workers, mechanics, materialmen, and furnishers of machinery and parts thereof, equipment, power tools, and all supplies, including commissary, incurred in the furtherance of the performance of this contract. The Contractor shall, at the Owner's request, furnish satisfactory evidence that all obligations of the nature hereinabove designated have been paid, discharged, or waived. If the Contractor fails so to do, then the Owner may, after having served written notice on the said Contractor, either pay unpaid bills, of which the Owner has written notice, direct, or withhold from the Contractor's unpaid compensation a sum of money deemed reasonably sufficient to pay any and all such lawful claims until satisfactory evidence is furnished that all liabilities have been fully discharged whereupon payment to the Contractor shall be resumed, in accordance with the terms of this contract, but in no event shall the provisions of this sentence be construed to impose any obligations upon the Owner to either the Contractor or his Surety. In paying any unpaid bills of the Contractor, the Owner shall be deemed the agent of the Contractor, and any payment so made by the Owner shall be considered as a payment made under the contract by the Owner to the Contractor and the Owner shall not be liable to the Contractor for any such payments made in good faith.

B. Payments by Contractor

The Contractor shall pay (a) for all transportation and utility services not later than the 20th day of the calendar month following that in which services are rendered, (b) for all materials, tools, and other expendable equipment to the extent of ninety percent (90%) of the cost thereof, not later than the 20th day of the calendar month following that in which such materials, tools, and equipment are delivered at the site of the project, and the balance of the cost thereof, not later than the 30th day following the completion of that part of the work in or on which such materials, tools, and equipment are incorporated or used, and (c) to each of his subcontractors, not later than the 5th day following each payment to the Contractor, the respective amounts allowed the Contractor on account of the work performed by his subcontractors to the extent of each subcontractor's interest therein.

C. Time for Completion and Liquidated Damages

It is hereby understood and mutually agreed, by and between the Contractor and the Owner, that the date of beginning and the time for completion as specified in the contract of the work to be done hereunder are ESSENTIAL CONDITIONS of this contract; and it is further mutually understood and agreed that the work embraced in this contract shall be commenced on a date to be specified in the "Notice to Proceed".

The Contractor agrees that said work shall be prosecuted regularly, diligently, and uninterruptedly at such rate of progress as will insure full completion thereof within the time specified. It is expressly understood and agreed, by and between the Contractor and the Owner, that the time for the completion of the work described herein is a reasonable time for the completion of the same, taking into consideration the average climatic range and usual industrial conditions prevailing in this locality.

If the said Contractor shall neglect, fail or refuse to complete the work within the time herein specified, or any proper extension thereof granted by the Owner, then the Contractor does hereby agree, as a part consideration for the awarding of this contract, to pay to the Owner the amount specified in the contract, not as a penalty but as liquidated damages for such breach of contract as hereinafter set forth, for each and every calendar day that the Contractor shall be in default after the time stipulated in the contract for completing the work.

The said amount is fixed and agreed upon by and between the Contractor and the Owner because of the impracticability and extreme difficulty of fixing and ascertaining the actual damages the Owner would in such event sustain, and said amount is agreed to be the amount of damages which the Owner would sustain and said amount shall be retained from time to time by the Owner from current periodical estimates.

It is further agreed that time is of the essence of each and every portion of this contract and of the specifications wherein a definite and certain length of time is fixed for the performance of any act whatsoever; and where under the contract an additional time is allowed for the completion of any work, the new time limit fixed by such extension shall be of the essence of this contract. Provided that the Contractor shall not be charged with liquidated damages or any excess cost when the Owner determines that the Contractor is without fault and the Contractor's reasons for the time extension are acceptable to the Owner; Provided further that the Contractor shall not to be charged with liquidated damages or any excess cost when the delay in completion of the work is due:

- (a) To any preference, priority or allocation order duly issued by the Government.
- (b) To unforeseeable cause beyond the control and without the fault or negligence of the Contractor, including, but not restricted to, acts of God, or of the public enemy, acts of the Owner, acts of another Contractor in the performance of a contract with the Owner, fires, floods, epidemics, quarantine restrictions, strikes, freight embargoes, and severe weather; and
- (c) To any delays of Subcontractors or suppliers occasioned by any of the causes specified in subsections (a) and (b) of this article:

Provided further that the Contractor shall, within ten (10) days from the beginning of such delay, unless the Owner shall grant a further period of time prior to the date of final settlement of the contract, notify the Owner, in writing, of the delay and notify the Contractor within a reasonable time of its decision in the matter.

D. Protection of Lives and Health

"The Contractor shall exercise proper precaution at all times for the protection of persons and property and shall be responsible for all damages to persons or property, either on or off the site, which occur as a result of his prosecution of the work. The safety provisions of applicable laws and building and construction codes, in addition to specific safety and health regulations described by Chapter XIII, Bureau of Labor Standards, Department of Labor, Part 1518, Safety and Health Regulations for Construction, as outlined in the Federal Register, Volume 36, No. 75, Saturday, April 17, 1971. Title 29 - LABOR, shall be observed and the Contractor shall take or cause to be taken, such additional safety and health measures as the Contracting Authority may determine to be reasonably necessary."

E. Subcontracts

The contractor or subcontractor shall insert in any subcontracts the clauses contained in 29 CFR 5.5 (a)(1) through (10) and such other clauses as the (Department of Housing and Urban Development) may by appropriate instructions require, and also a clause requiring the subcontractors to include these clauses in any lower tier subcontracts. The prime contractor shall be responsible for the compliance by any subcontractor or lower tier subcontractor with all the contract clauses in 29 CFR 5.5.

F. Interest of Member of or Delegate to Congress

No member of or Delegate to Congress, or Resident Commissioner, shall be admitted to any share or part of this contract or to any benefit that may arise there from, but this provision shall not be construed to extend to this contract if made with a corporation for its general benefit.

G. Other Prohibited Interests

No official of the Owner who is authorized in such capacity and on behalf of the Owner to negotiate, make, accept or approve, or to take part in negotiating, making, accepting, or approving any architectural, engineering, inspection, construction or material supply contract or any subcontract in connection with the construction of the project, shall become directly or indirectly interested personally in this contract or in any part hereof. No officer, employee, architect, attorney, engineer or inspector of or for the Owner who is authorized in such capacity and on behalf of the Owner to exercise any legislative, executive, supervisory or other similar functions in connection with the construction of the project, shall become directly or indirectly interested personally in this contract or in any part thereof, any material supply contract, subcontract, insurance contract, or any other contract pertaining to the project.

H. Use and Occupancy Prior to Acceptance by Owner

The Contractor agrees to the use and occupancy of a portion or unit of the project before formal acceptance by the Owner, provided the Owner:

- (a) Secures written consent of the Contractor except in the event, in the opinion of the Architect/Engineer, the Contractor is chargeable with unwarranted delay in final clean-up of punch list items or other contract requirements.
- (b) Secures endorsement from the insurance carrier and consent of the surety permitting occupancy of the building or use of the project during the remaining period of construction, or,
- (c) When the project consists of more than one building, and one of the buildings is occupied, secures permanent fire and extended coverage insurance, including a permit to complete construction. Consent of the surety must also be obtained.

I. Photographs of the Project

If required by the Owner, the Contractor shall furnish photographs of the project, in the quantities and as described in the Supplemental General Conditions.

J. Suspension of Work

Should the Owner be prevented or enjoined from proceeding with work either before or after the start of construction by reason of any litigation or other reason beyond the control of the Owner, the Contractor shall not be entitled to make or assert claim for damage by reason of said delay; but time for completion of the work will be extended to such reasonable time as the Owner may determine will compensate for time lost by such delay with such determination to be set forth in writing.

4. FEDERAL LABOR STANDARDS PROVISIONS

Applicability

The Project or Program to which the construction work covered by this contract pertains is being assisted by the United States of America and the following Federal Labor Standards Provisions are included in this Contract pursuant to the provisions applicable to such Federal assistance.

A. 1. (i) Minimum Wages

All laborers and mechanics employed or working upon the site of the work (or under the United States Housing Act of 1937 or under the Housing Act of 1949 in the construction or development of the project), will be paid unconditionally and not less often than once a week, and without subsequent deduction or rebate on any account (except such payroll deductions as are permitted by regulations issued by the Secretary of Labor under the Copeland Act (29 CFR Part 3), the full amount of wages and bona fide fringe benefits (or cash equivalents thereof) due at time of payment computed at rates not less than those contained in the wage determination of the Secretary of Labor which is attached hereto and made a part hereof, regardless of any contractual relationship which may be alleged to exist between the contractor and such laborers and mechanics. Contributions made or costs reasonably anticipated for bona fide fringe benefits under Section 1(b)(2) of the Davis-Bacon Act on behalf of laborers or mechanics are considered wages paid to such laborers or mechanics, subject to the provisions of 29 CFR 5.5(a)(1)(iv); also, regular contributions made or costs incurred for more than a weekly period (but not less than often than quarterly) under plans, funds, or programs, which cover the particular weekly period, are deemed to be constructively made or incurred during such weekly period.

Such laborers and mechanics shall be paid the appropriate wage rate and fringe benefits on the wage determination for the classification of work actually performed, without regard to skill, except as provided in 29 CFR Part 5.5(a)(iv). Laborers or mechanics performing work in more than one classification may be compensated at the rate specified for each classification for the time actually worked therein: provided, that the employer's payroll records accurately set forth the time spent in each classification in which work is performed. The wage determination (including any additional classification and wage rates conformed under 29 FR Part 5.5(a)(1)(ii) and the Davis-Bacon poster (WH-1321) shall be posted at all times by the contractor and its subcontractors at the site of the work in a prominent and accessible place where it can be easily seen by the workers.

- (ii)(a) Any class of laborers or mechanics which is not listed in the wage determination and which is to be employed under the contract shall be classified in conformance with the wage determination. HUD shall approve an additional classification and wage rate and fringe benefits therefore only when the following criteria have been met:

- (1) The work to be performed by the classification requested is not performed by a classification in the wage determination; and
 - (2) The classification is utilized in the area by the construction industry; and
 - (3) The proposed wage rate, including any bona fide fringe benefits, bears a reasonable relationship to the wage rates contained in the wage determination.
- (b) If the contractor and the laborers and mechanics to be employed in the classification (if known), or their representatives, and HUD or its designee agree on the classification and wage rate (including the amount designated for fringe benefits where appropriate), a report of the action taken shall be sent by HUD or its designee to the Administrator of the Wage and Hour Division, Employment Standards Administration, U.S. Department of Labor, Washington, D.C. 20210. The Administrator, or an authorized representative, will approve, modify, or disapprove every additional classification action within 30 days of receipt and so advise HUD or its designee or will notify HUD or its designee within the 30-day period that additional time is necessary. (Approved by the Office of Management and Budget under OMB Control Number 1215-0140.)
- (c) In the event the contractor, the laborers or mechanics to be employed in the classification or their representative, and HUD or its designee do not agree on the proposed classification and wage rate (including the amount designated for fringe benefits, where appropriate), HUD or its designee shall refer the questions, including the views of all interested parties and the recommendation of HUD or its designee, to the Administrator for determination. The Administrator, or an authorized representative, will issue a determination within 30 days of receipt and so advise HUD or its designee or will notify HUD or its designee within the 30-day period that additional time is necessary. (Approved by the Office of Management and Budget under OMB Control Number 1215-0140.)
- (d) The wage rate (including the fringe benefits where appropriate) determined pursuant to subparagraphs (1)(b) or (c) of this paragraph, shall be paid to all workers performing work in the classification under this contract from the first day on which work is performed in the classification.
- (iii) Whenever the minimum wage rate prescribed in the contract for a class of laborers or mechanics includes a fringe benefit which is not expressed as an hourly rate, the contractor shall either pay the benefit as stated in the wage determination or shall pay another bona fide fringe benefit or an hourly cash equivalent thereof.

- (iv) If the contractor does not make payments to a trustee or other third persons, the contractor may consider as part of the wages of any laborer or mechanic the amount of any costs reasonably anticipated in providing bona fide fringe benefits under a plan or program, provided, that the Secretary of Labor has found, upon the written request of the contractor, that the applicable standards of the Davis-Bacon Act have been met. The Secretary of Labor may require the contractor to set aside in a separate account assets for the meeting of obligations under the plan or program. (Approved by the Office of Management and Budget under OMB Control Number 1215-0140.)

2. Withholding

HUD or its designee shall upon its own action or upon written request of an authorized representative of the Department of Labor withhold or cause to be withheld from the contractor under this contract or any other Federal contract with the same prime contractor, or any other Federally-assisted contract subject to Davis-Bacon prevailing wage requirements, which is held by the same prime contractor so much of the accrued payments or advances as may be considered necessary to pay laborers and mechanics, including apprentices and trainees, employed by the contractor or any subcontractor the full amount of wages required by the contract.

In the event of failure to pay any laborer or mechanic, including any apprentice or trainee, employed or working on the site of the work (or under the United States Housing Act of 1937 or under the Housing Act of 1949 in the construction or development of the project), all or part of the wages required by the contract, HUD or its designee may, after written notice to the contractor, sponsor, applicant, or owner, take such action as may be necessary to cause the suspension of any further payment, advance, or guarantee of funds until such violations have ceased. HUD or its designee may, after written notice to the contractor, disburse such amounts withheld for and on account of the contractor or subcontractor to the respective employees to whom they are due. The Comptroller General shall make sure disbursements in the case of direct Davis-Bacon Act contracts.

3. (i) Payrolls and basic records.

Payrolls and basic records relating thereto shall be maintained by the contractor during the course of the work preserved for a period of three years thereafter for all laborers and mechanics working at the site of the work (or under the United States Housing Act of 1937, or under the Housing Act of 1949, in the construction or development of the project). Such records shall contain the name, address, and social security number of each such worker, his or her correct classification, hourly rates of wages paid (including rates of contributions or costs anticipated for bona fide fringe benefits or cash equivalents thereof of the types described in Section 1(b)(2)(B) of the Davis-Bacon Act), daily and weekly number of hours worked, deductions made and actual wages paid. Whenever the Secretary of Labor has found under 29 CFR 5.5 (a)(1)(iv) that the wages of any laborer or mechanic include the amount of any costs reasonably anticipated in providing benefits under a plan or program described in Section 1 (b)(2)(B) of the Davis-Bacon Act, the contractor shall maintain records which show that the commitment to provide such benefits is enforceable, that the plan or program is financially responsible, and that the plan or program has been communicated in writing to the laborers or mechanics affected, and records which show the costs anticipated or the actual cost incurred in providing such benefits. Contractors employing apprentices or trainees under approved programs shall maintain written evidence of the registration of apprenticeship programs and certification of trainee programs, the registration of the apprentices and trainees, and the ratios and wage rates prescribed in the applicable programs. (Approved by the Office of Management and Budget under OMB Control Numbers 1215-0140 and 1215-0017.)

- (ii)(a) The contractor shall submit weekly for each week in which any contract work is performed a copy of all payrolls to HUD or its designee if the agency is a party to the contract, but if the agency is not such a party, the contractor will submit the payrolls to the applicant, sponsor, or owner, as the case may be, for transmission to HUD or its designee. The payrolls submitted shall set out accurately and completely all of the information required to be maintained under 29 CFR Part 5.5(a)(3)(i). This information may be submitted in any form desired. Optional Form WH-347 is available for this purpose and may be purchased from the Superintendent of Documents (Federal Stock Number 029-005-00014-1), U.S. Government Printing Office, Washington, D.C. 20402. The prime contractor is responsible for the submission of copies of payrolls by all subcontractors. (Approved by the Office of Management and Budget under OMB Control Number 1215-0149).
- (b) Each payroll submitted shall be accompanied by a "Statement of Compliance," signed by the contractor or subcontractor or his or her agent who pays or supervises the payment of the persons employed under the contract and shall certify the following:
 - (1) That the payroll for the payroll period contains the information required to be maintained under 29 CFR Part 5.5(a)(3)(i) and that such information is correct and complete;

- (2) That each laborer or mechanic (including each apprentice and trainee) employed on the contract during the payroll period has been paid the full weekly wages earned, without rebate, either directly or indirectly, and that no deductions have been made either directly or indirectly from the full wages earned, other than permissible deductions as set forth in 29 CFR Part 3;
 - (3) That each laborer or mechanic has been paid not less than the applicable wage rates and fringe benefits or cash equivalents for the classification of work performed, as specified in the applicable wage determination incorporated into the contract.
- (c) The weekly submission of a properly executed certification set forth on the reverse side of Optional Form WH-347 shall satisfy the requirement for submission of the "Statement of Compliance" required by paragraph A.3.(ii)(b) of this section.
 - (d) The falsification of any of the above certifications may subject the contractor or subcontractor to civil or criminal prosecution under Section 1001 of Title 18 and Section 231 of Title 31 of the United States Code.
- (iii) The contractor or subcontractor shall make the records required under paragraph A.3.(i) of this section available for inspection, copying, or transcription by authorized representative of HUD or its designee or the Department of Labor, and shall permit such representative to interview employees during working hours on the job. If the contractor or subcontractor fails to submit the required records or to make them available, HUD or its designee may, after written notice to the contractor, sponsor, applicant, or owner, take such action as may be necessary to cause the suspension of any further payment, advance, or guarantee of funds. Furthermore, failure to submit the required records upon request or to make such records available may be grounds for debarment action pursuant to 29 CFR Part 5.12.
4. (i) Apprentices.

Apprentices will be permitted to work at less than the predetermined rate for the work they performed when they are employed pursuant to and individually registered in a bona fide apprenticeship program registered with the U.S. Department of Labor, Employment and Training Administration, Bureau of Apprenticeship and Training, or with a State Apprenticeship Agency recognized by the Bureau, or if a person is employed in his or her first 90 days of probationary employment as an apprentice in such an apprenticeship program, who is not individually registered in the program, but who has been certified by the Bureau of Apprenticeship and Training or a State Apprenticeship Agency (where appropriate) to be eligible for probationary employment as an apprentice. The allowable ratio of apprentices to journeymen on the job site in any craft classification shall not be greater than the ratio permitted to the contractor as to the entire work force under the registered program. Any worker listed on a payroll at an apprentice wage rate, who is not registered or otherwise employed as stated above, shall be paid not less than the applicable wage rate on the wage determination for the classification of work actually performed. In addition, any apprentice performing work on the job site in excess of the ratio permitted under the registered program shall be paid not less than the applicable wage rate on the wage determination for the work actually performed. Where a contractor is performing construction on a project in a locality other than that in which its program is registered, the ratios and wage rates (expressed in percentages of the journeyman's hourly rate) specified in the contractor's or subcontractor's registered program shall be observed. Every apprentice must be paid at not less than the rate specified in the registered program for the apprentice's level of progress, expressed as a percentage of the journeymen hourly rate specified in the applicable wage determination. Apprentices shall be paid fringe benefits in accordance with the provisions of the apprenticeship program. If the apprenticeship program does not specify fringe benefits, apprentices must be paid the full amount of fringe

benefits listed on the wage determination for the applicable classification. If the Administrator determines that a different practice prevails for the applicable apprentice classification, fringes shall be paid in accordance with that determination. In the event the Bureau of Apprenticeship and Training, or a State Apprenticeship Agency recognized by the Bureau, withdraws approval of an apprenticeship program, the contractor will no longer be permitted to utilize apprentices at less than the applicable predetermined rate for the work performed until an acceptable program is approved.

(ii) Trainees.

Except as provided in 29 CFR 5.16, trainees will not be permitted to work at less than the predetermined rate for the work performed unless they are employed pursuant to and individually registered in a program which has received prior approval, evidenced by formal certification by the U.S. Department of Labor, Employment and Training Administration. The ratio of trainees to journeymen on the job site shall not be greater than permitted under the plan approved by the Employment and Training Administration. Every trainee must be paid at not less than the rate specified in the approved program for the trainee's level of progress, expressed as a percentage of the journeyman hourly rate specified in the applicable wage determination. Trainees shall be paid fringe benefits in accordance with the provisions of the trainee program. If the trainee program does not mention fringe benefits, trainees shall be paid the full amount of fringe benefits listed on the wage determination unless the Administrator of the Wage and Hour Division determines that there is an apprenticeship program associated with the corresponding journeyman wage rate on the wage determination which provides for less than full fringe benefits for apprentices. Any employee listed on the payroll at a trainee rate who is not registered and participating in a training plan approved by the Employment and Training Administration shall be paid not less than the applicable wage rate on the wage determination for the work actually performed. In addition, any trainee performing work on the job site in excess of the ratio permitted under the registered program shall be paid not less than the applicable wage rate on the wage determination for the work actually performed. In the event the Employment and Training Administration withdraws approval of a training program, the contractor will no longer be permitted to utilize trainees at less than the applicable predetermined rate for the work performed until an acceptable program is approved.

(iii) Equal employment opportunity.

The utilization of apprentices, trainees and journeyman under this part shall be in conformity with the equal employment opportunity requirements of Executive Order 11246, as amended, and 29 CFR Part 30.

5. Compliance with Copeland Act requirements.

The contractor shall comply with the requirements of 29 CFR Part 3 which are incorporated by reference in this contract.

6. Subcontracts.

The contractor or subcontractor will insert in any subcontracts the clauses contained in 29 CFR 5.5(a)(1) through (10) and such other clauses as HUD or its designee may by appropriate instructions require, and also a clause requiring the subcontractors to include these clauses in any lower tier subcontracts. The prime contractor shall be responsible for the compliance by any subcontractor or lower tier subcontractor with all the contract clauses in 29 CFR Part 5.5

7. Contract termination; debarment.

A breach of the contract clauses in 29 CFR 5.5 may be grounds for termination of the contract, and for debarment as a contractor and a subcontractor as provided in 29 CFR 5.12.

8. Compliance with Davis-Bacon and Related Act Requirements.

All rulings and interpretations of the Davis-Bacon and Related Acts contained in 29 CFR Parts 1, 3, and 5 are herein incorporated by reference in this contract.

9. Disputes concerning labor standards.

Disputes arising out of the labor standards provisions of this contract shall not be subject to the general disputes clause of this contract. Such disputes shall be resolved in accordance with the procedures of the Department of Labor set forth in 29 CFR Parts 5, 6, and 7. Disputes within the meaning of this clause include disputes between the contractor (or any of its subcontractors) and HUD or its designee, the U.S. Department of Labor, or the employees or their representatives.

10. Certification of Eligibility.

(i) By entering into this contract, the contractor certifies that neither it (nor he or she) nor any person or firm who has an interest in the contractor's firm is a person or firm ineligible to be awarded Government contracts by virtue of Section 3(a) of the Davis-Bacon Act or 29 CFR 5.12(a)(1) or to be awarded HUD contracts or participate in HUD programs pursuant to 24 CFR Part 24.

(ii) No part of this contract shall be subcontracted to any person or firm ineligible for award of a Government contract by virtue of Section 3(a) of the Davis-Bacon Act or 29 CFR 5.12(a)(1) or to be awarded HUD contracts or participate in HUD programs pursuant to 24 CFR Part 24.

(iii) The penalty for making false statements is prescribed in the U.S. Criminal Code, 18 U.S.C. 1001. Additionally, U.S. Criminal Code, Section 1010, Title 18, U.S.C., "Federal Housing Administration transactions", provides in part "Whoever, for the purpose of ...influencing in any way the action of such Administration ...makes, utters or publishes any statement, knowing the same to be false ...shall be fined not more than \$5,000 or imprisoned not more than two years, or both."

11. Complaints, Proceedings, or Testimony by Employees.

No laborer or mechanic to whom the wage, salary, or other labor standards provisions of this Contract are applicable shall be discharged or in any other manner discriminated against by the Contractor or any subcontractor because such employee has filed any complaint or instituted or caused to be instituted any proceeding or has testified or is about to testify in any proceeding under or relating to the labor standards applicable under this Contract to his employer.

B. Contract Work Hours and Safety Standards Act

As used in this paragraph, the terms "laborers" and "mechanics" include watchmen and guards.

1. Overtime requirements.

No contractor or subcontractor contracting for any part of the contract work which may require or involve the employment of laborers or mechanics shall require or permit any such laborer or mechanic in any workweek in which he or she is employed on such work to work in excess of forty hours in such workweek unless such laborer or mechanic receives compensation at a rate not less than one and one-half times the basic rate of pay for all hours worked in excess of forty hours in such workweek.

2. Violation; liability for unpaid wages, liquidated damages.

In the event of any violation of the clause set forth in subparagraph (1) of this paragraph, the contractor and any subcontractor responsible therefore shall be liable for the unpaid wages. In addition, such contractor and subcontractor shall be liable to the United States (in the case of work done under contract for the District of Columbia or a territory, to such District or to such territory), for liquidated damages. Such liquidated damages shall be computed with respect to each individual laborer or mechanic, including watchmen and guards, employed in violation of the clause set forth in subparagraph (1) of this paragraph, in the sum of \$10 for each calendar day on which such individual was required or permitted to work in excess of the standard workweek of forty hours without payment of the overtime wages required by the clause set forth in subparagraph (1) of this paragraph.

3. Withholding for unpaid wages and liquidated damages.

HUD or its designee shall upon its own action or upon written request of an authorized representative of the Department of Labor withhold or cause to be withheld, from any moneys payable on account of work performed by the contractor or subcontractor under any such contract or any other Federal contract with the same prime contract, or any other Federally-assisted contract subject to the Contract Work Hours and Safety Standards Act, which is held by the same prime contractor such sums as may be determined to be necessary to satisfy any liabilities of such contractor or subcontractor for unpaid wages and liquidated damages as provided in the clause set forth in subparagraph (2) of this paragraph.

4. Subcontracts.

The contractor or subcontractor shall insert in any subcontracts the clauses set forth in subparagraph (1) through (4) of this paragraph and also a clause requiring the subcontractors to include these clauses in any lower tier subcontracts. The prime contractor shall be responsible for compliance by any subcontractor or lower tier subcontractor with the clauses set forth in subparagraphs (1) through (4) of this paragraph.

C. Health and Safety

1. No laborer or mechanic shall be required to work in surroundings or under working conditions which are unsanitary, hazardous, or dangerous to his health and safety as determined under construction safety and health standards promulgated by the Secretary of Labor by regulation.
2. The contractor shall comply with all regulations issued by the Secretary of Labor pursuant to Title 29 Part 1926 (formerly part 1518) and failure to comply may result in imposition of sanctions pursuant to the Contract Work Hours and Safety Standards Act (Public Law 91-54, 83 Stat. 96).
3. The Contractor shall include the provisions of this Article in every subcontract so that such provisions will be binding on each subcontractor. The Contractor shall take such action with respect to any subcontract as the Secretary of Housing and Urban Development or the Secretary of Labor shall direct as a means of enforcing such provisions.

5. SPECIAL HAZARDS

The Contractor's and his Subcontractor's Public Liability and Property Damage Insurance shall provide adequate protection against the following special hazards:

6. CONTRACTOR'S AND SUBCONTRACTOR'S PUBLIC LIABILITY, VEHICLE LIABILITY, AND PROPERTY DAMAGE INSURANCE

As required under Article 5 of the General Conditions, the Contractor's Public Liability Insurance and Vehicle Liability Insurance shall be in an amount not less than \$_____ for injuries, including accidental death, to any one person, and subject to the same limit for each person, in an amount not less than \$_____ on account of one accident, and Contractor's Property Damage Insurance in an amount not less than \$_____.

The Contractor shall either (1) require each of his subcontractors to procure and to maintain during the life of his subcontract, Subcontractor's Public Liability and Property Damage Insurance of this type and in the same amounts as specified in the preceding paragraph, or (2) insure the activities of his subcontractors in his own policy.

7. PHOTOGRAPHS OF PROJECT

As provided in Paragraph 3.1 of the Supplemental General Conditions, the Contractor will furnish photographs in the number, type, and stage as enumerated below:

8. SCHEDULE OF OCCUPATIONAL CLASSIFICATIONS AND MINIMUM HOURLY WAGE RATES AS REQUIRED UNDER PARAGRAPH 4.B OF THE SUPPLEMENTAL GENERAL CONDITIONS

Given on Pages _____, _____ and _____.

9. BUILDER'S RISK INSURANCE

As provided in the General Conditions, Article 5.6, the Contractor will/will not** maintain Builder's Risk Insurance (fire and extended coverage) on a 100 percent completed value basis on the insurable portions of the project for the benefit of the Owner, the Contractor, and all Subcontractors, as their interests may appear.

** Strike out one.

10. SPECIAL EQUAL OPPORTUNITY PROVISIONS

A. Activities and Contracts Not Subject to Executive Order 11246, as Amended

(Applicable to Federally assisted construction contracts and related subcontracts \$10,000 and under.)

During the performance of this contract, the Contractor agrees as follows:

1. The Contractor shall not discriminate against any employee or applicant for employment because of race, color, religion, sex, or national origin. The Contractor shall take affirmative action to ensure that applicants for employment are employed, and that employees are treated during employment, without regard to their race, color, religion, sex, or national origin. Such action shall include, but not be limited to, the following: employment, upgrading, demotion, or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship.
2. The Contractor shall post in conspicuous places, available to employees and applicants for employment, notices to be provided by Contracting Officer setting forth the provisions of this nondiscrimination clause. The Contractor shall state that all qualified applicants will receive consideration for employment without regard to race, color, religion, sex, or national origin.
3. Contractors shall incorporate foregoing requirements in all subcontracts.

B. Executive Order 11246 (contracts/subcontracts above \$10,000)

1. Section 202 Equal Opportunity Clause

During the performance of this contract, the Contractor agrees as follows:

- a. The Contractor will not discriminate against any employee or applicant for employment because of race, color, religion, sex, or national origin. The Contractor will take affirmative action to ensure that applicants are employed, and that employees are treated during employment, without regard to their race, color, religion, sex, or national origin. Such action shall include, but not be limited to, the following: employment, upgrading, demotion, or transfer; recruitment, or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship. The Contractor agrees to post in conspicuous places, available to employees and applicants for employment, notices to be provided setting forth the provisions of this nondiscrimination clause.
- b. The Contractor will, in all solicitations or advertisements for employees placed by or on behalf of the Contractor, state that all qualified applicants will receive consideration without regard to race, color, religion, sex, or national origin.
- c. The Contractor will send to each labor union or representative of workers with which he has a collective bargaining agreement or other contract or understanding a notice to be provided by the Contract Compliance Officer advising the said labor union or workers' representatives of the Contractor's commitment under this section, and shall post copies of the notice in conspicuous places available to employees and applicants for employment.
- d. The Contractor will comply with all provisions of Executive Order 11246 of September 24, 1965, and of the rules, regulations, and relevant orders of the Secretary of Labor.
- e. The Contractor will furnish all information and reports required by Executive Order 11246 of September 24, 1965, and by rules, regulations, and orders of the Secretary of Labor, or pursuant thereto, and will permit access to his books, records, and accounts by the Department of the Secretary of Labor for purposes of investigation to ascertain compliance with such rules, regulations, and others.
- f. In the event of the Contractor's noncompliance with the nondiscrimination clauses of this contract or with any of the said rules, regulations, or orders, this contract may be cancelled, terminated, or suspended in whole or in part and the Contractor may be declared ineligible for further Government contracts in accordance with procedures authorized in Executive Order 11246 of September 24, 1965, or by rule, regulation, or order of the Secretary of Labor, or as otherwise provided by law.

g. The Contractor will include the provisions of the sentence immediately preceding paragraph a. and the provisions of paragraphs a. through g. in every subcontract or purchase order unless exempted by rules, regulations, orders of the Secretary of Labor issued pursuant to Section 204 of Executive Order 11246 of September 24, 1965, so that such provisions will be binding upon each subcontractor or vendor. The Contractor will take such action with respect to any subcontract or purchase order as the Department may direct as a means of enforcing such provisions, including sanctions for non-compliance. Provided, however, that in the event a contractor becomes involved in, or is threatened with, litigation with a subcontractor or vendor as a result of such direction by the Department, the Contractor may request the United States to enter into such litigation to protect the interest of the United States.

2. Notice of Requirement for Affirmative Action to ensure Equal Employment Opportunity (Executive Order 11246).
 (Applicable to contracts/subcontracts exceeding \$10,000.)

- a. The Offeror's or Bidder's attention is called to the "Equal Opportunity Clause" and the "Standard Federal Equal Employment Opportunity Construction Contract Specifications" set forth herein.
- b. The goals and timetables for minority and female participation, expressed in percentage terms for the Contractor's aggregate workforce in each trade on all construction work in the covered area, are as follows:

Goals for minority participation	Goals for female participation
Insert Goals	Insert Goals
_____	_____

NOTE: THESE GOALS MUST BE PROVIDED. Also, list State Geographic Area to be covered on following page.

These goals are applicable to all the Contractor's construction work (whether or not it is Federal or Federally assisted) performed in the covered area. If the Contractor performs construction work in a geographic area located outside of the covered area, it shall apply the goals established for such geographic area where the work is actually performed. With regard to this second area, the Contractor also is subject to the goals for both its Federally involved and non-Federally involved construction.

The contractor's compliance with the Executive Order and the regulations in 41 CFR Part 60-4 shall be based on its implementation of the Equal Opportunity Clause, specific affirmative action obligations required by the specifications set forth in 41 CFR 60-4.3(a), and its efforts to meet the goals established for the geographical area where the contract resulting from this solicitation is to be performed. The hours of minority and female employment and training must be substantially uniform throughout the length of the contract, and in each trade, and the Contractor shall make a good faith effort to employ minorities and women evenly on each of its projects. The transfer of minority or female employees or trainees from Contractor to Contractor or from project to project for the sole purpose of meeting the Contractor's goals shall be a violation of the contract, the Executive Order, and the regulations in 41 CFR Part 60-4. Compliance with the goals will be measured against the total work hours performed.

- c. The Contractor shall provide written notification to the Director of the Office of Federal Contract Compliance Programs within 10 working days of award of any construction subcontract in excess of \$10,000 at any tier for construction work under the contract resulting from this solicitation. The notification shall list the name, address, and telephone number of the subcontractor; employer identification number; estimated dollar amount of the subcontract; estimated starting and completion dates of the subcontract; and the geographical area in which the contract is to be performed.
- d. As used in this Notice, and in the contract resulting from this solicitation, the "covered area" is _____.

3. Standard Federal Equal Employment Opportunity Construction Contract Specifications (Executive Order 11246)

- a. As used in these specifications:
 - (1) "Covered area" means the geographical area described in the solicitation from which this contract resulted;
 - (2) "Director" means Director, Office of Federal Contract Compliance Programs, United States Department of Labor, or any person to whom the Director delegates authority;
 - (3) "Employer identification number" means the federal social security number used on the Employer's Quarterly Federal Tax Return, U.S. Treasury Department Form 941;
 - (4) "Minority" includes:
 - (a) Black (all persons having origins in any of the Black African racial groups not of Hispanic origin);

- (b) Hispanic (all persons of Mexican, Puerto Rican, Cuban, Central or South America or other Spanish Culture or origin, regardless of race);
 - (c) Asian and Pacific Islander (all persons having origins in any of the original peoples of the Far East, Southeast Asia, the Indian Subcontinent, or the Pacific Islands);
 - (d) American Indian or Alaskan Native (all persons having origins in any of the original peoples of North America and maintaining identifiable tribal affiliations through membership and participation or community identification).
- b. Whenever the Contractor, or any Subcontractor at any tier, subcontracts a portion of the work involving any construction trade, it shall physically include in each subcontract in excess of \$10,000 the provisions of these specifications and the Notice which contains the applicable goals for minority and female participation and which is set forth in the solicitations from which this contract resulted.
- c. If the Contractor is participating (pursuant to 41 CFR 60-4.5) in a Hometown Plan approved by the U.S. Department of Labor in the covered area either individually or through an association, its affirmative action obligations on all work in the Plan area (including goals and timetables) shall be in accordance with that Plan for those trades which have unions participating in the Plan. Contractors must be able to demonstrate their participation in and compliance with the provisions of any such Hometown Plan. Each Contractor or Subcontractor participating in an approved Plan is individually required to comply with its obligations under the EEO clause, and to make a good faith effort to achieve each goal under the Plan in each trade in which it has employees. The overall good faith performance by other Contractors or Subcontractors toward a goal in an approved Plan does not excuse any covered Contractor's or Subcontractor's failure to take good faith efforts to achieve the Plan goals and timetables.

- d. The Contractor shall implement the specific affirmative action standards provided in paragraphs g.(1) through (16) of these specifications. The goals set forth in the solicitation from which this contract resulted are expressed as percentages of the total hours of employment and training of minority and female utilization the Contractor should reasonably be able to achieve in each construction trade in which it has employees in the covered area. Covered construction contractors performing contracts in geographical areas where they do not have a Federal or Federally-assisted construction contract shall apply the minority and female goals established for the geographic area where the contract is being performed. Goals are published periodically in the Federal Register in notice form and such notices may be obtained from any Office of Federal Contract Compliance Programs office or from Federal procurement contracting officers. The Contractor is expected to make substantially uniform progress in meeting its goals in each craft during the period specified.
- e. Neither the provisions of any collective bargaining agreement, nor the failure by a union with whom the Contractor has a collective bargaining agreement, to refer either minorities or women shall excuse the Contractor's obligations under these specifications, Executive Order 11246, or the regulations promulgated pursuant thereto.
- f. In order for the nonworking training hours of apprentices and trainees to be counted in meeting the goals, such apprentices and trainees must be employed by the Contractor during the training period, and the Contractor must have made a commitment to employ the apprentices and trainees at the completion of their training, subject to the availability of employment opportunities. Trainees must be trained pursuant to training programs approved by the U.S. Department of Labor.
- g. The Contractor shall take specific affirmative actions to ensure equal employment opportunity. The evaluation of the Contractor's compliance with these specifications shall be based upon its effort to achieve maximum results from its actions. The Contractor shall document these efforts fully, and shall implement affirmative action steps at least as extensive as the following:

- (1) Ensure and maintain a working environment free of harassment, intimidation, and coercion at all sites, and in all facilities at which the Contractor's employees are assigned to work. The Contractor, where possible, will assign two or more women to each construction project. The Contractor shall specifically ensure that all foremen, superintendents, and other on-site supervisory personnel are aware of and carry out the Contractor's obligation to maintain such a working environment, with specific attention to minority or female individuals working at such sites or in such facilities.
- (2) Establish and maintain a current list of minority and female recruitment sources, provide written notification to minority and female recruitment sources and to community organizations when the Contractor or its union have employment opportunities available, and maintain a record of the organization's responses.
- (3) Maintain a current file of the names, addresses, and telephone numbers of each minority and female off-the-street applicant and minority or female referral from a union, a recruitment source, or community organization and of what action was taken with respect to each such individual. If such individual was sent to the union hiring hall for referral and was not referred back to the Contractor by the union or, if referred, not employed by the Contractor, this shall be documented in the file with the reason therefore, along with whatever additional actions the Contractor may have taken.
- (4) Provide immediate written notification to the Director when the union or unions with which the Contractor has a collective bargaining agreement has not referred to the Contractor a minority person or woman sent by the Contractor, or when the Contractor has other information that the union referral process has impeded the Contractor's efforts to meet its obligations.
- (5) Develop on-the-job training opportunities and/or participate in training programs for the area which expressly include minorities and women, including upgrading programs and apprenticeship and trainee programs relevant to the Contractor's employment needs, especially those programs funded or approved by the Department of Labor. The Contractor shall provide notice of these programs to the sources compiled under g.(2) above.

- (6) Disseminate the Contractor's EEO policy by providing notice of the policy to unions and training programs and requesting their cooperation in assisting the Contractor in meeting its EEO obligations; by including it in any policy manual and collective bargaining agreement; by publicizing it in the company newspaper, annual report, etc.; by specific review of the policy with all management personnel and with all minority and female employees at least once a year; and by posting the company's EEO policy on bulletin boards accessible to all employees at each location where construction work is performed.
- (7) Review, at least annually, the company's EEO policy and affirmative action obligations under these specifications with all employees having any responsibility for hiring, assignment, layoff, termination, or other employment decisions including specific review of these items with on-site supervisory personnel such as Superintendents, General Foremen, etc., prior to the initiation of construction work at any job site. A written record shall be made and maintained identifying the time and place of these meetings, persons attending, subject matter discussed, and disposition of the subject matter.
- (8) Disseminate the Contractor's EEO policy externally by including it in any advertising in the news media, specifically including minority and female news media, and providing written notification to and discussing the Contractor's EEO policy with other Contractors and Subcontractors with whom the Contractor does or anticipates doing business.
- (9) Direct its recruitment efforts, both oral and written, to minority, female and community organizations, to schools with minority and female students and to minority and female recruitment and training organizations serving the Contractor's recruitment area and employment needs. Not later than one month prior to the date of the acceptance of applications for apprenticeship or other training by any recruitment source, the Contractor shall send written notification to organizations such as the above, describing the openings, screening procedures, and tests to be used in the selection process.
- (10) Encourage present minority and female employees to recruit other minority persons and women and, where reasonable, provide after school, summer, and vacation employment to minority and female youth both on the site and in other areas of a Contractor's work force.

- (11) Validate all tests and other selection requirements where there is an obligation to do so under 41 CFR part 60-3.
 - (12) Conduct, at least annually, an inventory and evaluation at least of all minority and female personnel for promotional opportunities and encourage these employees to seek or to prepare for, through appropriate training, etc., such opportunities.
 - (13) Ensure that seniority practices, job classifications, work assignments and other personnel practices, do not have a discriminatory effect by continually monitoring all personnel and employment related activities to ensure that the EEO policy and the Contractor's obligations under these specifications are being carried out.
 - (14) Ensure that all facilities and company activities are nonsegregated except that separate or single-user toilet and necessary changing facilities shall be provided to assure privacy between the sexes.
 - (15) Document and maintain a record of all solicitations of offers for subcontracts from minority and female construction contractors and suppliers, including circulation of solicitations to minority and female contractor associations and other business associations.
 - (16) Conduct a review, at least annually, of all supervisors' adherence to and performance under the Contractor's EEO policies and affirmative action obligations.
- h. Contractors are encouraged to participate in voluntary associations which assist in fulfilling one or more of their affirmative action obligations g.(1) through (16). The efforts of a contractor association, joint contractor-union, contractor-community, or other similar group of which the Contractor is a member and participant, may be asserted as fulfilling any one or more of its obligations under g.(1) through (16) of these Specifications provided that the Contractor actively participates in the group, makes every effort to assure that the group has a positive impact on the employment of minorities and women in the industry, ensures that the concrete benefits of the program are reflected in the Contractor's minority and female workforce participation, makes a good faith effort to meet its individual goals and timetables, and can provide access to documentation which demonstrates the effectiveness of actions taken on behalf of the Contractor. The obligation shall not be a defense for the Contractor's non-compliance.

- i. A single goal for minorities and a separate single goal for women have been established. The Contractor, however, is required to provide equal employment opportunity and to take affirmative action for all minority groups, both male and female, and all women, both minority and non-minority. Consequently, the Contractor may be in violation of the Executive Order if a particular group is employed in a substantially disparate manner (for example, even though the Contractor has achieved its goals for women generally the Contractor may be in violation of the Executive Order if a specific minority group of women is underutilized).
- j. The Contractor shall not use the goals and timetables or affirmative action standards to discriminate against any person because of race, color, religion, sex, or national origin.
- k. The Contractor shall not enter into any Subcontract with any person or firm debarred from Government contracts pursuant to Executive Order 11246.
- l. The Contractor shall carry out such sanctions and penalties for violation of these specifications and of the Equal Opportunity Clause, including suspension, termination and cancellation of existing subcontracts as may be imposed or ordered pursuant to Executive Order 11246, as amended, and its implementing regulations, by the Office of Federal Contract Compliance Programs. Any contractor who fails to carry out such sanctions and penalties shall be in violation of these specifications and Executive Order 11246, as amended.
- m. The Contractor, in fulfilling its obligations under these specifications, shall implement specific affirmative action steps, at least as extensive as those standards prescribed in paragraph g. of these specifications, so as to achieve maximum results from its efforts to ensure equal employment opportunity. If the Contractor fails to comply with the requirements of the Executive Order, the implementing regulations, or these specifications, the Director shall proceed in accordance with 41 CFR 60-4.8.

- n. The Contractor shall designate a responsible official to monitor all employment related activity to ensure that the company's EEO policy is being carried out, to submit reports relating to the provisions hereof as may be required by the Government and to keep records. Records shall at least include for each employee, the name, address, telephone numbers, construction trade, union affiliation if any, employee identification number where assigned, social security number, race, sex, status (e.g., mechanic, apprentice trainee, helper, or laborer), dates of changes in status, hours worked per week in the indicated trade, rate of pay, and location at which the work was performed. Records shall be maintained in an easily understandable and retrievable form; however, to the degree that existing records satisfy this requirement, contractor shall not be required to maintain separate records.
- o. Nothing herein provided shall be construed as a limitation upon the application of other laws which establish different standards of compliance or upon the application of requirements for the hiring of local or other area residents (e.g., those under the Public Works Employment Act of 1977 and the Community Development Block Grant Program).

C. Certification of Nonsegregated Facilities (Over \$10,000)

By the submission of this bid, the bidder, offeror, applicant or subcontractor certifies that he/she does not maintain or provide for his/her employees any segregated facility at any of his/her establishments, and that he/she does not permit employees to perform their services at any location, under his/her control, where segregated facilities are maintained. He/She certifies further that he/she will not maintain or provide for employees any segregated facilities at any of his/her establishments, and he/she will not permit employees to perform their services at any location under his/her control where segregated facilities are maintained. The bidder, offeror, applicant or subcontractor agrees that a breach of this certification is a violation of the Equal Opportunity Clause of this contract. As used in this certification, the term "segregated facilities" means any waiting rooms, work areas, rest rooms and wash rooms, restaurants and other eating areas, time clocks, locker rooms, and other storage or dressing areas, ***transportation and housing facilities provided for employees which are segregated on the basis of race, color, religion, or are in fact segregated on the basis of race, color, religion, or otherwise. He/She further agrees that (except where he/she has obtained identical certifications from proposed subcontractors for specific time periods) he/she will obtain identical certification from proposed subcontractors prior to the award of subcontracts exceeding \$10,000 which are not exempt from the provisions of the Equal Opportunity Clause; that he/she will retain such certifications in his/her files; and that he/she will forward the following notice to such proposed subcontractors (except where proposed subcontractors have submitted identical certifications for specific time periods).

D. Civil Rights Act of 1964

Under Title VI of the Civil Rights Act of 1964, no person shall, on the grounds of race, color, or national origin, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any program or activity receiving Federal financial assistance.

E. Section 109 of the Housing and Community Development Act of 1974

No person in the United States shall on the grounds of race, color, national origin, or sex be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any program or activity funded in whole or in part with funds made available under this title.

F. "The Section 3 Clause"

1. The work to be performed under this contract is on a project assisted under a program providing direct Federal financial assistance from the Department of Housing and Urban Development and is subject to the requirements of section 3 of the Housing Urban Development Act of 1968, as amended, 12 U.S.C. 1701u. Section 3 requires that to the greatest extent feasible, opportunities for training and employment be given to lower income residents of the area of the Section 3 covered project, and contracts for work in connection with the project be awarded to business concerns which are located in, or owned in substantial part by persons residing in the area of the Section 3 covered project.
2. The parties to this contract will comply with the provisions of said Section 3 and the regulations issued pursuant thereto by the Secretary of Housing and Urban Development set forth in 24 Part CFR 135, and all applicable rules and orders of the Department issued thereunder prior to the execution of this contract. The parties to this contract certify and agree that they are under no contractual or other disability which would prevent them from complying with these requirements.
3. The contractor will send to each labor organization or representative of workers with which he has a collective bargaining agreement or other contract or understanding, if any, a notice advising the said labor organization or workers' representative of his commitments under this Section 3 clause and shall post copies of the notice in conspicuous places available to employees and applicants for employment or training.
4. The contractor will include this Section 3 clause in every subcontract for work in connection with the project and will, at the direction of the applicant for or recipient of Federal Financial assistance, take appropriate action pursuant to the subcontract upon a finding that the subcontractor is in violation of regulations issued by the Secretary of Housing and Urban Development, 24 CFR Part 135. The contractor will not subcontract with any subcontractor where it has notice or knowledge that the latter has been found in violation of regulations under 24 CFR part 135 and will not let any subcontract unless the subcontractor has first provided it with a preliminary statement of ability to comply with the requirements of these regulations.

5. Compliance with the provisions of Section 3, the regulations set forth in 24 CFR Part 135, and all applicable rules and orders of the Department issued thereunder prior to the execution of the contract, shall be a condition of the Federal financial assistance provided to the project, binding upon the applicant or recipient, its contractors and subcontractors, its successors, and assigns to those sanctions specified by the grant or loan agreement or contract through which Federal assistance is provided, and to such sanctions as are specified by 24 CFR Part 135.

G. Age Discrimination Act of 1975

No person in the United States shall, on the basis of age, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under, any program or activity receiving Federal financial assistance.

H. Section 504 Handicapped

Non-Discrimination for Handicapped Workers

No otherwise qualified handicapped individual in the U.S., as defined in Section 7, Paragraph 6 of the Rehabilitation Act of 1973 shall, solely by reason of this handicap, be excluded from the participation in, be denied the benefits of, or be subjected to discrimination under any program or activity receiving Federal financial assistance.

11. **CERTIFICATION OF COMPLIANCE WITH AIR AND WATER ACTS**

(Applicable to Federally assisted construction contracts and related subcontracts exceeding \$100,000)

Compliance with Air and Water Acts

During the performance of this contract the contractor and all subcontractors shall comply with the requirements of the Clean Air Act, as amended, 42 USC 1857 et seq., the Federal Water Pollution Control Act, as amended, 33 USC 1251 et seq., and the regulations of the Environmental Protection Agency with respect thereto, at 40 CFR Part 15, as amended.

In addition to the foregoing requirements, all nonexempt contractors and subcontractors shall furnish to the Owner, the following:

1. A stipulation by the Contractor or subcontractors, that any facility to be utilized in the performance of any nonexempt contract or subcontract, is not listed on the List of Violating Facilities issued by the Environmental Protection Agency (EPA) pursuant to 40 CFR 15.20.

2. Agreement by the Contractor to comply with all the requirements of Section 114 of the Clean Air Act, as amended, (42 USC 1857c-8) and Section 308 of the Federal Water Pollution Control Act, as amended, (33 USC 1318) relating to inspection, monitoring, entry, reports and information, as well as all other requirements specified in said Section 114 and Section 308, and all regulations and guidelines issued thereunder.
3. A stipulation that as a condition for the award of the contract, prompt notice will be given of any notification received from the Director, Office of Federal Activities, EPA, indicating that a facility utilized, or to be utilized for the contract, is under consideration to be listed on the EPA List of Violating Facilities.
4. Agreement by the Contractor that he will include, or cause to be included, the criteria and requirements in paragraph (1) through (4) of this section in every nonexempt subcontract and requiring that the Contractor will take such action as the Government may direct as a means of enforcing such provisions.

12. SPECIAL CONDITIONS PERTAINING TO HAZARDS, SAFETY STANDARDS AND ACCIDENT PREVENTION

A. Lead-Based Paint Hazards

(Applicable to contracts for construction or rehabilitation of residential structures.)
The construction or rehabilitation of residential structures is subject to the HUD Lead-Based Paint regulations, 24 CFR Part 35. The Contractor and Subcontractors shall comply with the provisions for the elimination of lead-base paint hazards under sub-part B of said regulations. The Owner will be responsible for the inspections and certifications required under Section 35.14(f) thereof.

B. Use of Explosives (Modify as Required)

When the use of explosives is necessary for the prosecution of the work, the Contractor shall observe all local, state and Federal laws in purchasing and handling explosives. The Contractor shall take all necessary precaution to protect completed work, neighboring property, water lines, or other underground structures. Where there is danger to structures or property from blasting, the charges shall be reduced and the material shall be covered with suitable timber, steel or rope mats.

The Contractor shall notify all owners of public utility property of intention to use explosives at least eight hours before blasting is done, close to such property. Any supervision or direction of use of explosives by the engineer, does not in any way reduce the responsibility of the Contractor or his Surety for damages that may be caused by such use.

C. Danger Signals and Safety Devices (Modify as Required)

The Contractor shall make all necessary precautions to guard against damages to property and injury to persons. He shall put up and maintain in good condition, sufficient red or warning lights at night, suitable barricades and other devices necessary to protect the public. In case the Contractor fails or neglects to take such precautions, the Owner may have such lights and barricades installed and charge the cost of this work to the Contractor. Such action by the Owner does not relieve the Contractor of any liability incurred under these specifications or contract.

13. FLOOD DISASTER PROTECTION

This Contract is subject to the requirements of the Flood Disaster Protection Act of 1973 (P.L. 93-234). Nothing included as a part of this Contract is approved for acquisition or construction purposes as defined under Section 3(a) of said Act, for use in an area identified by the Secretary of HUD as having special flood hazards which is located in a community not then in compliance with the requirements for participation in the national flood insurance program pursuant to Section 201(d) of said Act; and the use of any assistance provided under this Contract for such acquisition or construction in such identified areas in communities then participating in the national flood insurance program shall be subject to the mandatory purchase of flood insurance requirements of Section 102(a) of said Act.

Any contract or agreement for the sale, lease, or other transfer of land acquired, cleared or improved with assistance provided under the Contract shall contain, if such land is located in an area identified by the Secretary as having special flood hazards and in which the sale of flood insurance has been made available under the National Flood Insurance Act of 1968, as amended, 42 U.S.C. 4001 et seq., provisions obligating the transferee and its successors or assigns to obtain and maintain, during the ownership of such land, such flood insurance as required with respect to financial assistance for acquisition or construction purposes under Section 102(a) of the Flood Disaster Protection Act of 1973.

14. ACCESS TO RECORDS/MAINTENANCE OF RECORDS

The Contractor shall maintain accounts and records, including personnel, property, and financial records, adequate to identify and account for all costs pertaining to the contract and such other records as may be deemed necessary by the locality to assure proper accounting for all funds. These records will be available for audit purposes to the locality or the State or any other authorized representative, and will be retained for three years after contract completion unless permission to destroy them is granted by the locality. Moreover, the locality, State, or any authorized representative shall have access to any books, documents, papers, and records of the Contractor which are directly pertinent to this contract for the purpose of making audit, examination, excerpts, and transcriptions.

15. CONFLICT OF INTEREST OF OFFICERS OR EMPLOYEES OF THE LOCAL JURISDICTION, MEMBERS OF THE LOCAL GOVERNING BODY, OR OTHER PUBLIC OFFICIALS

No officer or employee of the local jurisdiction or its designees or agents, no member of the governing body, and no other public official of the locality who exercises any function or responsibility with respect to this contract, during his/her tenure or for one year thereafter, shall have any interest, direct or indirect, in any contract or subcontract, or the proceeds thereof, for work to be performed. Further, the contractor shall cause to be incorporated in all subcontracts the language set forth in this paragraph prohibiting conflict of interest.

16. DRUG-FREE WORKPLACE

Under the provisions of Tennessee Code Annotate § 50-9-113 enacted by the General Assembly effective 2001, a) employers with five (5) or more employees who contract with either the state or a local government to provide construction services are required to submit an affidavit stating that they have a drug free workplace program that complies with Title 50, Chapter 9, in effect at the time of submission of a bid at least to the extent required of governmental entities. The statute, imposes other requirements on the contractor, but the grantee's responsibility is specifically limited in section (b) of the state as follows:

(b) A written affidavit by the principal officer of a covered employer provided to a local government at the time such bid or contract is submitted stating that the employer is in compliance with this section shall absolve the local government of all further responsibility under this section and any liability arising from the employer's compliance or failure of compliance with the provisions of this section.

17. PROJECT SIGN

If a project sign is erected, it must include the following:

Governor *(Name)*
Department of Economic and Community Development
Commissioner *(Name)*
CDBG Grant *(Amount)*

SPECIFICATIONS

Description of Project

Location (Recipient)

List of Contracts

Contract No.

Name and Address of Consultant or, if Prepared by
Recipient Staff, the Name of the Office to be Contacted for
Information Pertaining to Project

Appendix D

Project Permits



STATE OF TENNESSEE
DEPARTMENT OF ENVIRONMENT AND CONSERVATION
DIVISION OF WATER RESOURCES
William R. Snodgrass - Tennessee Tower
312 Rosa L. Parks Avenue, 11th Floor
Nashville, Tennessee 37243-1102

April 10, 2024

Mr. Justin Robinette, P.E.
e-copy: jrobinette@husseygaybell.com
Hussey Gay Bell
4117 Hillsboro Pike, Suite 206
Nashville, 37215

Subject: **Pikeville Wastewater Treatment Plant**
County: Bledsoe
Wastewater Project Number: 23.0552
Project: Pikeville 0.366 MGD Wastewater Treatment Plant

Dear Mr. Robinette:

The Tennessee Department of Environment and Conservation, Division of Water Resources, acknowledges the receipt of your construction documents on September 21, 2023 and with updated information on April 4, 2024.

The project consists of the construction of a new 0.366 MGD wastewater treatment plant. The new facility will include a grinder and mechanical screen, one carousel aeration basin, two clarifiers, a chlorine contact chamber, aerobic digestion, and a solids handling facility.

Approval is granted in accordance with certain requirements of the Water Quality Control (WQC) Act of 1977 and Regulations of the Water Quality Control Board. **On the coversheet(s) of the site's set of plans and specifications, an approval date and its expiration date will be stamped by the division. Any indication of tampering with the bound set of documents will be subject to investigation and prosecution.** One complete set of construction documents, bearing the official stamp, must be kept at the construction site.

Approval expires one year from the stamped approval date (April 9, 2024) unless construction is either underway or complete. Any request for extension must be made prior to this expiration date. Significant deviations from the approved plan documents must be submitted and approved in writing before such changes are made. Minor changes made during construction need not have prior written approval. Modifications, however, may be required by this

Department should the changes be deemed inappropriate. It is advisable, therefore to obtain prior approval in cases where the significance of the change is uncertain.

The Division of Water Resources is authorized to inspect the construction work to verify compliance with the approved plans and specifications, which are on the site. Therefore, the engineer shall notify our staff at the Chattanooga Environmental Field Office by calling (423) 634-5745 before the start of construction.

Approval of these construction documents should not be construed as a permit for any activities related to this project. Activities which may require a permit under the WQC Act and Regulations include, but are not limited to, the following: streambank vegetation removal; creek crossing(s) for equipment or utility lines; construction within twenty (20) feet of a stream bank; construction in or near a marshy area or wetland, and/or land disturbance equal to or greater than one acre. Additionally, this approval does not authorize connection and use of sewer that will cause or contribute to collection system overflow or overload of receiving wastewater treatment facility.

The Chattanooga Environmental Field Office should also be contacted for determinations regarding whether modification of the existing NPDES or SOP permit, an Aquatic Resource Alteration Permit (ARAP) and/or a National Pollutant Discharge Elimination System (NPDES) construction stormwater permit will need to be obtained prior to the beginning of construction of this project.

The division's most recent TDEC Technical/Engineering Documents, including "*Design Criteria for Review of Sewage Works Construction Plans and Documents*", Chapters 1-17, of November 1, 2017, is available on our website: <https://www.tn.gov/environment/program-areas/wr-water-resources/water-quality/water-quality-reports---publications.html>.

To expedite matters, please reference the assigned wastewater project number 23.0552 on any future correspondence. If you have any questions, please feel free to contact Mr. Tim Hill, P.E. at (865) 364-9535 or by E-mail at Timothy.Hill@tn.gov.

Sincerely,



Angela Jones, P.E.
Manager, Engineering Services Unit

cc: Water-Based Systems File
Mr. Justin Thomas, Wastewater Supervisor, Town of Pikeville, pikevillewastewater@aol.com
Ms. Jennifer H. Innes, Unit Manager, TDEC - Chattanooga Environmental Field Office, Jennifer.Innes@tn.gov
Mr. Trent Hodges, PE, Hussey Gay Bell, thodges@husseygaybell.com



Under the Aquatic Resource Alteration
General Permit for Construction of Intake and Outfall Structures

Tennessee Department of Environment and Conservation
Division of Water Resources
William R. Snodgrass Tennessee Tower
312 Rosa L. Parks Avenue, 11th Floor
Nashville TN 37243

ARAP - NR2301.129

Under authority of the Tennessee Water Quality Control Act of 1977 (TWQCA, T.C.A. 69-3-101 et seq.) the Division of Water Resources has determined the activity described below would not violate applicable water quality standards.

This activity is governed by the *General Permit for Construction of Intake and Outfall Structures* issued pursuant to the TWQCA. The work must be accomplished in conformance with accepted plans, specifications, data and other information submitted in support of application NR2301.129 and the terms and conditions set forth in the above referenced general permit.

PERMITTEE: City of Pikeville

AUTHORIZED WORK: installation of two outfall structures

LOCATION: 25 Municipal Drive, P.O. Box 225, Bledsoe County

Latitude: 35.595 Longitude: -85.193

WATERBODY NAME: Sequatchie River

EFFECTIVE DATE: 22-FEB-24

EXPIRATION DATE: 07-APR-25

This does not preclude requirements of other federal, state or local laws. In particular, work shall not commence until the applicant has received the federal §404 permit from the U. S. Army Corps of Engineers, a §26a permit from the Tennessee Valley Authority or authorization under a Tennessee NPDES Storm Water Construction Permit where necessary. This permit may also serve as a federal §401 water quality certification (pursuant to 33 U.S.C. §1341) since the planned activity was reviewed and the division has reasonable assurance that the activity will be conducted in a manner that will not violate applicable water quality standards (T.C.A. § 69-3-101 et seq. or of § § 301, 302, 303, 306 or 307 of *The Clean Water Act*). The 401 Water Quality Certification Justifications and Citations related to the procedural requirements of §121.7(d) can be found at <https://www.tn.gov/environment/permit-permits/water-permits/aquatic-resource-alteration-permit-arap.html>.

A paper copy of the certifications and justifications can also be obtained by contacting water.permits@tn.gov or calling (615) 532-0359.

The state of Tennessee may modify, suspend or revoke this authorization should the state determine that the activity results in more than an insignificant degradation of applicable water quality standards or violation of the TWQCA. Failure to comply with permit terms may result in penalties in accordance with T.C.A. §69-3-115.



STATE OF TENNESSEE
DEPARTMENT OF ENVIRONMENT AND CONSERVATION
DIVISION OF WATER RESOURCES
CHATTANOOGA Environmental Field Office
1301 RIVERFRONT PARKWAY, SUITE 206
CHATTANOOGA, Tn 37402

February 22, 2024

Mr. Justin Thomas
W. W. Manager
City of Pikeville
e-copy: pikevillewastewater@aol.com
25 Municipal Drive
Pikeville, TN 37367

Subject: **General Permit for Construction of Intake and Outfall Structures
Aquatic Resource Alteration Permit (ARAP) NR2301.129
Pikeville Wastewater Treatment Plant
City of Pikeville
Pikeville, Bledsoe County, Tennessee**

Dear Mr. Thomas:

We have reviewed your application for the proposed installation of two outfall structures .

Pursuant to the *Tennessee Water Quality Control Act of 1977* (T.C.A. §§ 69-3-101 et seq.) and supporting regulations the Division of Water Resources is required to determine whether the activity described in the attached Notice of Coverage will violate applicable water quality standards. This permit may also serve as a federal section 401 water quality certification (pursuant to 33 U.S.C. § 1341). The 401 Water Quality Certification Justifications and Citations related to the procedural requirements of §121.7(d) can be found at <https://www.tn.gov/environment/permit-permits/water-permits/aquatic-resource-alteration-permit-arap.html>. A paper copy of the certifications and justifications can also be obtained by contacting water.permits@tn.gov or calling (615) 532-0359.

This activity is governed by the *General Permit for Construction of Intake and Outfall Structures*. The work must be accomplished in conformance with accepted plans and information submitted in support of application NR2301.129 and the limitations and conditions set forth in the *General Permit for Construction of Intake and Outfall Structures* (enclosed). It is the responsibility of the permittee to ensure that all contractors involved with this project have read and understand the permit conditions before the project begins.

Please note that authorization under this general permit is only for the construction of the structures and does not authorize water withdrawal or release. These structures may not cause bank erosion due to increased velocity or improper alignment. Adequate erosion controls must be installed prior to construction and maintained during construction of the project. All disturbed areas must be revegetated or otherwise stabilized upon completion of construction.

Please note that authorization under this general permit is only for the construction of the structures and does not authorize water withdrawal or release. These structures may not cause bank erosion due to increased velocity or improper alignment. Adequate erosion controls must be installed prior to

construction and maintained during construction of the project. All disturbed areas must be revegetated or otherwise stabilized upon completion of construction.


Annual Maintenance and Coverage Termination

Permittees will be assessed an annual maintenance fee of \$350 for coverages that exceed one year. Please note that this maintenance fee does not grant the right to extend coverage past the expiration date of the General Permit.

Permittees may terminate coverage prior to the expiration date by submitting a completed notice of termination form (NOT), which is available on the division's webpage at http://tdec.tn.gov/etdec/DownloadFile.aspx?row_id=CN-1450. A complete NOT should include photodocumentation of the finished project area. The division will notify the permittee that either the NOT was received and accepted, or that the permit coverage is not eligible for termination (due to existing deficiencies) and has not been terminated.

We appreciate your attention to the terms and conditions of this general permit for aquatic resource alteration. If you have any questions, please contact Ms. Nikki Carpenter at (423) 661-5267 or by e-mail at Nikki.Carpenter@tn.gov.

Sincerely,



Jennifer Innes
Environmental Program Manager

Encl: NOC and copy of general permit

CC: Chattanooga EFO Permit File

Ms. Gabrielle McAllister, TDEC Environmental Scientist 2, Chattanooga EFO,
Gabrielle.McAllister@tn.gov

Ms. Caroline Lewis, Hussey Gay Bell, clewis@husseygaybell.com

Mr. Justin Robinette, P.E., Managing Director, Hussey Gay Bell Nashville, LLC,
jrobinette@husseygaybell.com



STATE OF TENNESSEE
DEPARTMENT OF ENVIRONMENT AND CONSERVATION
DIVISION OF WATER RESOURCES
William R. Snodgrass - Tennessee Tower
312 Rosa L. Parks Avenue, 11th Floor
Nashville, Tennessee 37243-1102

October 12, 2023

Mr. Robert Stigall, PE
Hussey Gay Bell
e-copy: rstigall@husseygaybell.com
4117 Hillsboro Pike, Suite 206
Nashville, TN 37215

Subject: **Engineering Report and Preliminary Plans for Pikeville 0.366 MGD
Wastewater Treatment Plant
Pikeville Wastewater Treatment Plant
Wastewater Project Number: 22.0729
County: Bledsoe**

Dear Mr. Stigall:

The Tennessee Department of Environment and Conservation, Division of Water Resources, acknowledges the receipt of the above-referenced engineering report and preliminary plans. The report and plans will be used to provide an engineering basis for the design plans and specifications for the Pikeville 0.366 MGD Wastewater Treatment Plant. This project is affiliated with and will consist of the design and construction of a new 0.366 MGD wastewater treatment plant. New treatment plant will be comprised of a headworks unit, one carrousel aeration basin, two clarifiers, chlorine contact chamber, aerobic digestion, and a solids handling facility.

Any substantial changes to the engineering report should be submitted to the Division for comment prior to submittal of the final plans and specifications. Minor changes to the engineering report may be submitted with final plans and specifications. We are returning an approved report for your records.

The Division's most recent TDEC Technical/Engineering Documents, including "Design Criteria for Sewage Works Construction Plans and Documents", Chapters 1-17 is available on our website: <https://www.tn.gov/environment/program-areas/wr-water-resources/water-quality/water-quality-reports---publications.html>.

To expedite matters, please reference 22.0729 on any future correspondence. If we may be of any assistance, please feel free to contact Mr. Tim Hill, P.E. at (865) 364-9535 or by E-mail at *Timothy.Hill@tn.gov*.

Sincerely,

Handwritten signature of Timothy Hill in black ink, written in a cursive style.

for

Angela Jones, P.E.

Manager, Engineering Service Unit

cc:

Ms. Jennifer H. Innes, Unit Manager, TDEC - Chattanooga Environmental Field Office,
Jennifer.Innes@tn.gov

Mr. Justin Thomas, Wastewater Supervisor, Town of Pikeville, *pikevillewastewater@aol.com*