April 21, 2010
January 7, 2011
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Tennessee Department of Transportation
Division of Materials and Tests

Manufacture and Acceptance of Pre-cast Concrete Drainage Structures, Noise Wall Panels, and Earth Retaining Wall Products (SOP 5-3)

Purpose- The purpose of this document is to establish the minimum qualifications for the manufacture and acceptance of pre-cast drainage structures, noise wall panels, and earth retaining wall products. The precast drainage structures include pipe, headwalls, manholes, catchbasins, box culverts, structural spans. This document will provide the requirements for producers, testing guidelines, re-testing procedures, and product identification.

Background- TDOT Standard Specifications and Standard Drawings generally specify drainage structures to be in accordance with AASHTO and/or ASTM Standards. These Standards provide the design requirements and various materials and testing procedures.

Procedures-

1.0 Product Category- All producers shall request from the Division of Materials & Tests approval for the appropriate category(s) for which they wish to supply products to TDOT projects.

Category 1: Square/Rectangular Catchbasins, Stormwater Manholes, Endwalls, Junction Boxes, and Spring Boxes

Category 2: Round Catchbasins, Stormwater Manholes, Junction Boxes, and Spring Boxes

Category 3: Noise Wall Panels, Earth Retaining Walls, Box Culverts and Structural Spans

Category 4: Reinforced Concrete Pipe

2.0 Producer Requirements-

2.1 All producers of precast concrete drainage structures, noise wall panels, and earth retaining wall products to be supplied on TDOT projects shall be CERTIFIED by an approved National Quality Control Program as shown below:

- Pipe: ACPA or NPCA
- All other precast structures: ACPA, NPCA, or PCI

*ACPA- American Concrete Pipe Association
*NPCA – National Precast Concrete Association
*PCI – Pre-stressed Concrete Institute

Approved Producers must submit a copy of their current certification along with documentation that the annual inspections have been successfully completed.

2.2 A destructive test shall be required for any producer requesting to supply from Category 1 and dimensional and reinforcement verification for any producer requesting to supply from Category 2 in order to demonstrate the ability to manufacture units that meet TDOT Standards or a manufacturer's alternate detail drawing (stamped by Professional Engineer). Products selected for destructive testing from Category 1 can be manufactured to any detailed drawing, but shall be held to the manufacturing tolerances stated in Part 3 of this SOP.

3.0 Standard Drawings- All precast concrete products shall be manufactured in accordance to the dimensions and details shown on the following: TDOT Standard Drawings or the manufacturer's approved alternate detail to the standard drawing for Category 1 and Category 2 products, plans, and ASTM/AASHTO Specifications. Manufacturers shall be limited to one alternate detail to the standard drawing per each size product per year that has been designed and stamped by an engineer licensed to practice in Tennessee for approval. Alternate details will be valid until a change is made to the standard drawing or another alternate detail for that product is submitted and approved by TDOT. There will only be one approved alternate detail per manufacturer per product at any given time. Any alternate detail drawing submitted which contains design revisions other than dimensional variances are required to include the proper documentation as stated in Part 4: Submission of Substitution Designs of this SOP. All alternate details to the standard drawings are to be submitted to Regional Materials and Tests and will then be sent to the appropriate division for review.

4.0 Materials-

4.1 Aggregates- All aggregates used for wet and dry cast products shall be in accordance with Section 903.01, 903.03, and 903.22 of the TDOT Standard Specifications. The percentage of wear for coarse aggregates shall not exceed 40 when tested in accordance with AASHTO T-96.

4.2 Cement- All cements shall meet the requirements of Section 901.01 and be on the TDOT Qualified Product List (QPL). The producer shall retain copies of material certifications with chemical and physical properties.

4.3 Fly Ash, Ground granulated blast furnace slag, silica fume- other cementitious and pozzolanic materials must meet the requirements of Sections 918.31 or 918.32, and be on the TDOT QPL.

4.4 Reinforcing steel and wire strands- steel used for reinforcement of the drainage structures shall be in accordance with the applicable AASHTO or ASTM Standard for the structure, or as required by TDOT Standard Drawings. All certifications shall contain a signed Buy America statement. The producer shall retain copies of all mill test reports and material certifications.

4.5 Admixtures- All admixtures must comply with sections 604.03 and 918.09 of the TDOT Standard Specifications and be on the TDOT QPL.

5.0 Mixture Design-

5.1 The producer shall submit to TDOT for approval a concrete mixture design for each mixture that will be used. The mixture design submittal shall contain the minimum information required in subsection 604.03 of the Specifications. **The mixture design will be valid for a one-year period (January 1st – December 31st) and must be resubmitted annually.** Mix designs for the upcoming year shall be submitted no later than November 1st. Initial review of the mix designs shall be completed by December 31st. Any changes in material suppliers will require a new design submittal. The minimum cement content for any pipe shall be 470 lbs/CY. The minimum cementitious content and maximum water-cement ratio for wet cast products shall be 564 lbs/CY and 0.40 respectively. Concrete for noise wall panels shall meet the requirements of sub-section 604.03 Class "A" concrete. Concrete for retaining wall panels shall meet the requirements of sub-section 604.03 Class "A" concrete with the following requirements: minimum cement content 620 lbs/CY, maximum water-cement ratio 0.40, and minimum compressive strength of 4000 psi. The maximum allowable substitution rates of cementitious materials will be as specified in section 604.03 of the TDOT Specifications. All other mix design criteria (i.e. strength, etc...) shall be in accordance with the applicable AASHTO/ASTM Standard Specifications, Approved Shop Drawings, or TDOT Standard Drawings and Specifications.

5.2 Producers requesting to use self-compacting concrete (SCC) mixtures must submit a design in accordance with the chemical admixture manufacturer's recommendations and further demonstrate through trial batches that the mixture can be produced homogeneously without segregation. The TDOT must witness and approve the trial batch demonstrations for acceptance.

6.0 Quality Control Program-

6.1 Quality Control Plan (QCP) - Each production facility shall have a TDOT Specific Quality Control Plan as required by the applicable National Certification Program. Each QCP for the upcoming year shall be submitted no later than November 1st. Review of the QCP shall be completed by December 31st. The QCPs shall be submitted at the same time as mix designs for the upcoming year.

6.2 Testing Equipment and Laboratory-

6.2.1 Each production facility shall have, or have immediate access to a "Type A" laboratory as defined in Section 106.06 of the Specifications to conduct quality control testing. Laboratory qualifications shall meet requirements stated in SOP 1-4 (Laboratory Qualification Requirements).

6.2.2 Each production facility that is CERTIFYING products for acceptance must have a compression machine that is of sufficient capacity to test to the required strength of cylinders or cores and/or a "testing rack" for conducting three-edge bearing for testing pipe products to the required ultimate load strengths. A private testing laboratory, approved by the Department, may be used for

compressive testing. The testing laboratory shall be accredited through the AASHTO Accreditation Program (AAP).

6.2.3 The testing equipment shall be certified a minimum of every 12 months. The producer shall maintain documentation and records of all certifications.

6.2.4 Gradations shall be performed at the precast facility on each aggregate used at least once per month.

6.3 Quality Control Personnel-

6.3.1 Each production facility shall have an individual responsible for the quality production of precast products. This individual shall have authority to make necessary adjustments, reject concrete, cease production, or reject products when the quality of the product is in question.

6.3.2 Technicians and other individuals who conduct sampling and testing for quality control must be at least TDOT level 2 certified, or other approved equal. Any individuals submitting concrete mixture designs must be TDOT level 3 certified, or other approved equal. TDOT may grant reciprocity for required certifications. For consideration, a written letter and proof of certification must be sent to Headquarters Materials and Tests requesting reciprocity for TDOT Level 2 or 3. A Certified Level 2 Technician (QC Personnel) shall be on site anytime that a TDOT product is being produced.

6.4 Concrete Batching/Central Mixing Plant-

6.4.1 The concrete batch/central mixing plant shall have all scales, weighing devices, and/or metering devices calibrated and correlated a minimum of every 6 months. Documentation shall be available to show the calibration results.

6.4.2 Concrete may be supplied by a ready mix producer provided the plant and hauling equipment are in compliance with section 501.04 and 604.03 of the TDOT Specifications. The plant must be further approved by TDOT and meet requirements stated in SOP 4-3 (Ready Mix Concrete Plant Certification Procedures).

7.0 Acceptance Testing-

7.1 All testing for acceptance shall be completed, as a minimum, in accordance with TABLE 1. For dry cast applications, a LOT is defined as one week, Sunday to Saturday, and SUB-LOT is daily. A LOT is daily for all wet cast applications. All testing shall be in accordance with ASTM C-497 (AASHTO T-280).

7.2 A product will be accepted if: 1- All the acceptance test results for the LOT comply with the requirements of the applicable specification (ASTM, AASHTO, or TDOT), and 2- the product is manufactured within the dimensional tolerances as set forth in the appropriate ASTM/AASHTO Specification. See Part Three for Precast Manufacturing Tolerances.

7.3 Retesting- When an acceptance test fails to meet the requirements specified, then the product is unacceptable. Retesting will be allowed as follows:

7.3.1 D-Load test (or compressive strength for SUB-LOT) - The producer shall randomly sample and test 2 (two) additional pipe pieces from that SUB-LOT. Both test results must exceed the required D-load strength (or compressive strength) for the SUB-LOT to be acceptable. If both tests do not meet specified strengths then each individual pipe must be test for acceptance.

7.3.2 Ultimate Load and Absorption- The producer must retest a piece of pipe from the same day's production that failed to comply initially and one from another day's production during that week. Both test results must exceed the required Ultimate Load and Absorption for the LOT to be acceptable. If both tests do not meet the requirements, then 2 pieces of pipe from each day of that week must be tested and both pieces must pass for the daily LOT to be acceptable.

7.3.3 Compressive Strength (Wet Cast)-

7.3.3.1 If acceptance by cylinders: 1 (one) additional set of backup cylinders may be tested for acceptance. If the cylinders do not meet specified strengths, then 2 (two) cores shall be taken from different pieces for testing. Both test results must exceed the required compressive strength requirement for the LOT to be acceptable.

7.3.3.2 If acceptance by cores: 2 (two) additional cores shall be taken from different pieces for testing. Both test results must exceed the required compressive strength requirement for the LOT to be acceptable.

TABLE 1- Minimum Testing Frequencies for Acceptance

PRODUCT		D-LOAD (0.01" crack)	Ultimate Load[4]	Absorption[4]	Compressive Strength [1,2,3]
DRY CAST	Round Pipe- Diameter ≤30"	1/ day[6]	1/ month	1/ month	D-Load
	Round Pipe- Diameter ≥36"	1/ day or compressive strength [6]	1/ week or compressive strength	1/ month	1/ day or D-Load
	Arch Pipe- <26 5/8" x 43 3/8"	1/ week	1/ month	1/ month	D-Load
	Arch Pipe- ≥ 26 5/8" x 43 3/8"	1/ week or compressive strength	1/ week or compressive strength	1/ month	1/ week or Ultimate Load
	Elliptical Pipe- < 29" x 45"	1/ week	1/ month	1/ month	D-Load
	Elliptical Pipe- ≥ 29" x 45"	1/ week or compressive strength	1/ week or compressive strength	1/ month	1/ week or Ultimate Load
WET CAST	Manholes				1/ day min.[5]
	Catchbasins				1/ day min.[5]
	Structural Spans				1/ day min.[5]
	Box Culverts				1/ day min.[5]
	Endwalls				1/ day min.[5]
	Noise and retaining wall panels[7]				1/ day min.[5]

1- Compression strength may either be by core (minimum 3.75" diameter) or cylinders (4" x 8" or 6 x 12" cylinders)
2- Compression strength must be 100% of the specified strength to be acceptable
3- A pair of cylinders, if used in lieu of coring, shall be made at a minimum of 3 random points during production. The cylinders shall be cured in the same manner as the products they represent. One pair of cylinders shall be retained for TDOT verification testing for at least 14 days.
4- A piece of pipe tested to ultimate shall be tested for Absorption. Only one absorption test per month is required per design. Absorption may be tested in accordance with ASTM C497, Section 7, Method B
5- Six cylinders/day per mixture minimum. If the same mixture design is used in all products then the 6 specimens will represent all products manufactured that day
6- When small quantities (20 sections or less) per week of a product are produced, 1 test per week will be acceptable.
7- Noise and retaining wall panels require 1 air and slump test per day.

8.0 Stamping/Etching- Each pre-cast product produced shall be marked, by either stamping or etching, with the following information:

8.1 Pipe- Date of manufacture, diameter, AASHTO/ASTM designation and class, and the manufacturing plant's unique stamp/location identifier.

8.2 Other than pipe: Date of manufacture, AASHTO/ASTM designation and class, TDOT Standard type or the manufacturers approved alternate detail to the standard drawing number, project/contract number, and the manufacturing plant's unique stamp/location identifier.

8.3 Each product accepted by certification must also have "Certified" clearly stamped on the product.

9.0 Documentation and Reporting- The manufacturer shall keep daily reports documenting each product made that day and the number made. The report shall identify all the applicable information as stated in Sections 7.1 or 7.2, and results of all acceptance tests made for that product. The manufacturer shall maintain this information for a minimum of 5 years. All documents are subject to review by the Department.

10.0 TDOT Verification Testing and Inspection-

10.1 The Tennessee Department of Transportation retains the right to test and/or request the producer to retest any SUB-LOT or LOT for verification purposes. . Verification may include any of the acceptance tests identified. The frequency of verification testing may vary at the discretion of the Regional Materials Supervisor. When an acceptance test is conducted once a day then a minimum of one verification test must be conducted once a week. If an acceptance test is conducted once per week then a verification test must be conducted once per month. If an acceptance test is conducted once per month then a verification test is required once every 6 months

10.2 If verification test results do not reasonably comply with acceptance tests then all products represented by the manufacturer's acceptance test results will be considered "questionable for acceptance" and additional testing will be required.

10.3 Additional testing will entail that 2 (two) additional samples of product manufactured the same day as the verification sample will be tested. Both test results must comply with the requirements of the applicable test. If one sample results in a failure and does not comply with specification requirements, then all products from that day are considered unacceptable, and shall not be used on Department projects.

10.4 If products are deemed unacceptable as determined in Section 9.3, then additional verification testing shall be conducted on other products produced.

10.5 TDOT shall maintain records and documentation of all verification testing for 3 years.

10.6 TDOT shall have the right to review and inspect all producer quality control data, records, and files to assure compliance with these requirements.

10.7 TDOT Headquarters Materials and Tests shall make random quality control inspections at each plant yearly. A checklist of items will be reviewed by Headquarters Materials and Tests. Following the inspection, any deficient findings will be presented to the producer in a list of action items. The producer must address these action items to the satisfaction of TDOT within one month.

11.0 Precast Product Verification by Destructive Testing-

11.1 **Category 1**: Endwalls and Square/Rectangular Catchbasins, Stormwater Manholes, Junction Boxes, and Spring Boxes including Lids.
TDOT shall randomly select a minimum of one precast product from Category 1 at each plant for destructive testing every 6 months. Also, TDOT shall randomly select a minimum of one Category 1 precast product on a project in each region for destructive testing per year.

11.2 **Category 2**: Round Catchbasins, Stormwater Manholes, Spring Boxes, and Junction Boxes including Lids.
TDOT shall randomly select a minimum of one precast product from Category 2 at each plant for dimensional and reinforcement verification every 6 months.

11.3 **Category 3**: Noise Wall Panels, Earth Retaining Walls, Box Culverts and Structural Spans
TDOT shall accept Category 3 based off certification and parameters set forth in SOP 1-1. Box culverts shall be randomly selected for dimensional and reinforcement verification. Should a box culvert not pass dimensional or reinforcement verification then the product may be destructively tested.

11.4 **Category 4**: Reinforced Concrete Pipe
TDOT shall accept Category 4 based off testing as stated in this SOP and SOP 1-1.

11.5 All destructive testing at the plant will be performed by the manufacturer under the observation of TDOT. Regional Materials and Tests shall randomly determine when and what products to destructively test. All destructive testing at the plant will be at the cost of the manufacturer and any equipment needed for destructive testing shall be made available by the manufacturer for random inspection. TDOT will coordinate the regional test to ensure all plants have at least one item tested statewide each year.

11.6 For destructive testing on projects, Regional Materials and Tests shall identify a product to be tested and the contractor shall be responsible for arranging destructive testing to be performed as directed. Regional Materials and Tests shall consult with the project supervisor to eliminate any items needed within 3 weeks on the project for testing. The cost of any destructive testing on projects will be paid at the bid price assuming the structure tested meets TDOT Specifications. In the event of a failure, the cost of destructive testing and retesting will be assumed by the manufacturer.

11.7 Products selected for verification by destructive testing shall be manufactured to a TDOT Standard Drawing or an approved manufacturer's alternate detail drawing (stamped by Professional Engineer). These products shall have been produced between the date of the last passing inspection date and the current date.

11.8 If a producer cannot supply a TDOT product or private item for destructive testing or dimensional and reinforcement verification from a plant or project based off the requirements for Categories 1 and 2, then they will be given 6 months to provide a product for testing. If after 6 months the producer does not have a product for destructive testing or dimensional and reinforcement verification, they will be

removed from the Producers/Suppliers List of the specific category that a product was not supplied for 6 months. In order to be placed back on the Producers/Suppliers List, the producer shall then meet the requirements for a new producer including product demonstration for these categories.

11.9 See Part One for Destructive Testing Procedures and Part Two for the Evaluation Forms.

12.0 Removal of Precast Plant from Producers/Suppliers List-

12.1 All producers of precast concrete drainage structures, noise wall panels, and earth retaining wall products to be supplied on TDOT projects shall be CERTIFIED by an approved National Quality Control Program as shown below:

- Pipe: ACPA or NPCA
- All other precast structures: ACPA, NPCA, or PCI

*ACPA- American Concrete Pipe Association
*NPCA – National Precast Concrete Association
*PCI – Pre-stressed Concrete Institute

If a producer fails to maintain their certification they will not be allowed to produce products for use on TDOT projects and will be removed from the Producer/Supplier List.

12.2 TDOT shall remove a producer from the Producers/Suppliers List if they fail to manufacture, test, accept, or certify in accordance with the procedure set forth herein.

12.3 TDOT shall remove a producer from the Producers/Suppliers List if they falsify acceptance test results or certify/stamp products that do not meet acceptance criteria.

12.4 TDOT shall remove a producer from the Producers/Suppliers List if TDOT verification by destructive testing, as stated in Section 11.0, indicates that a product being manufactured contains a major error.

12.4.1 All errors in excess of two times the allowable tolerance, as stated in Part 3, are considered major errors and qualify for rejection.

12.4.2 Any missing or undersized steel is considered a major error.

12.4.3 Any errors that exceed the tolerances, as stated in Part 3, but are less than two times the stated tolerance are considered minor errors.

12.4.4 All errors shall be reported to the appropriate certifying institution by the producer.

12.4.5 Producers shall submit within one month from the time they receive the final report an action plan to Headquarters Materials and Tests to address any errors found.

12.5 If a randomly selected item is found to contain a major error that meets the requirement for removal from the Producers/Suppliers List as defined in 12.4, the producer may conduct additional testing in the presence of TDOT or their appointed representative as shown below. If the producer chooses not to conduct additional testing the appropriate time for removal from the Producers/Suppliers List shall be imposed.

12.5.1 TDOT will notify the producer of any failures. The producer may then choose to have a retest performed by contacting Regional Materials & Tests within 5 days of this notification. Retesting will take place according to 12.5.2.

12.5.2 TDOT will select two additional items for testing. These items must be the same type product manufactured at the same facility. When testing on a project if no additional items of the same type are found, then select a product from the same manufacturer's facility. When testing at the manufacturer's facility if no additional items of the same type are found, then select a product from a project that was made at that same facility.

12.5.3 The producer will destructively test the units as directed by TDOT or their appointed representative.

12.5.4 If either of the additional two units tested contain a major error, the appropriate time for removal from the Producers/Suppliers List shall be imposed.

12.6 If a facility is removed from the Producers/Suppliers List, they shall not supply any products to a TDOT project for the category from which they were removed.

12.6.1 Installed items shall be left in place.

12.6.2 Producers shall provide TDOT with a list of products supplied to TDOT projects from the date of the last passing inspection that will include certifications and contract numbers.

12.6.3 Uninstalled items on projects are subject to being recalled from the date of the last passing test until the date of the failing destructive test based on further evaluation by an agreed upon 3rd party. All cost incurred will be the responsibility of the producer.

12.6.4 Recalled items shall be clearly marked "RECALLED" in red. No recalled units will be allowed for use on TDOT projects.

12.6.5 Products on the producer's yard produced from the date of the last passing test until the date of the failing test may not be acceptable for use based on further evaluation by an agreed upon 3rd party. All cost incurred will be the responsibility of the producer.

12.6.6 Products not acceptable for use on the producer's yard shall have all TDOT information covered or removed from the product.

12.7 Time of facility removal, for each product category where product was manufactured, from Producer/Supplier List

12.7.1 First finding will result in the facility being removed for a minimum of 4 months.

12.7.2 Any offense in a two year period which will begin from the date the producer was placed back on the PSL from the **first** offense will result in the facility being removed for a minimum of 8 months.

12.7.3 Any offense in a two year period which will begin from the date the producer was placed back on the PSL from the **second** offense will result in the facility being removed for a minimum of 12 months.

12.7.4 Any more than 3 findings and TDOT will make a determination of any additional appropriate actions.

12.8 Before any producer may resume shipping products to TDOT projects, they must provide a Quality Control Plan addressing actions taken resolving any issues of non-compliance. A random destructive test must be performed on a product from the category for which the producer was removed once production has begun, but prior to shipping. The product selected shall be manufactured either to a TDOT Standard Drawing or an approved manufacturer's alternate detail drawing (stamped by Professional Engineer). If the producer is placed back on the approved Producers/Suppliers List, after the calendar year in which they were removed, they must follow the guidelines for new producers as stated in Sections 1.0-6.0 of this SOP.

13.0 Reporting- Regional Materials and Tests shall send a letter to the producer within one week stating the final status of the verification testing and a list of action items to be addressed. Regional Materials and Tests shall then compile the final verification testing report. Headquarters Materials and Tests shall send final reports to the manufacturer upon request.

14.0 Shipment- The producer must submit a completed certification form to be signed by the Quality Control Manager as designated in the QCP for each shipment to a TDOT project. An example form is attached, with the minimum information required. This form shall contain a statement certifying the products were manufactured, tested, and accepted in accordance with TDOT Procedures.

No products shall be shipped from the fabrication plant/stockyard until they have met all acceptance criteria.

American Concrete Pipe Association

NPCA

Date July 14, 2003 Contract number CNB 555 Report Number 1234567890
Project Number 123458-987-04 Contractor Joe's Pipe Installation Co. County Davidson

We, Precast - R-Us, Inc.., located in _____, certify that the following products have been made in reasonable close conformance to the lines and grades shown as specified in accordance with: TDOT Standard Drawings, TDOT Standard Specifications, Approved plans, Approved shop drawings, and/or AASHTO/ASTM Standards. We also certify that the test results documented are correct, and the product has been completed in full accordance with the TDOT procedures for the manufacture of Pre-cast Concrete Products.

Components, where applicable, meet stipulations of Special Provision 106A, *SPECIAL PROVISION REGARDING BUY AMERICA REQUIREMENTS*.

Reinforced concrete pipe:

Pipe Size/ Class/Wall	Date Mfg'd	D- Load to produce 0.01" crack	D- Load to produce ultimate load	Concrete Strength (psi)	Absorption percent	Quantity	Identification Number
18"-III- B ASTM C-76	6/25/03	1650	2450		5.2%	80 LF	12345
18"-III- B ASTM C-76	6/28/03	1600	2450		5.2%	96 LF	98765

Pre-cast concrete manholes, catch basins, end walls, box culverts, retaining walls, noise walls, etc…:

Item/type/dimensions/Structure Number	Date Mfg'd	Concrete Strength (PSI)	TDOT Drawing Number	Quantity	Identification Number
Type 12 Manhole- 32" x 32" x 48" Structure # 25 with risers and top	7/1/03	5600	DCB-12-LP	1 (8 feet)	12345
Noise wall panels 60" x 72" x 5"	6/27/03	5445	From Plan Sheet pg. 55	25 panels = 83.3 SY	98765

Signature: of Quality Control Manager
Date: July 14, 2003