
Work Plan for

**NTPEP Evaluation of Spray
Applied Non-Structural and
Structural Pipe Liners for Storm
Water Conveyance**

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INTRODUCTION

The National Transportation Product Evaluation Program (NTPEP) was established to minimize the amount of duplicative testing of transportation materials performed by AASHTO member states by providing a process where manufacturers submit their products to NTPEP for laboratory and/or field testing. The results of the testing are then shared with member Departments for their use in product quality verification.

This work plan provides the NTPEP member department's information on material specifications for non-structural cementitious and resin based spray applied liners for storm water conveyance conduits. In keeping with the NTPEP philosophy of purely testing materials, no conclusions are provided with the test results. The evaluation of the test results is left up to each member department.

1. SCOPE

1.1 This work plan covers the requirements and testing criteria for the National Transportation Product Evaluation Program (NTPEP) evaluation of non-structural and structural cementitious and resin based spray applied liners for storm water conveyance conduits. The National Transportation Product Evaluation Program (NTPEP) serves the member departments of the American Association of State Highway and Transportation Officials (AASHTO).

1.2 The results of this program may be used for product quality verification by individual member Departments. If used for quality verification, a letter of certification from the cementitious or resin based spray manufacturer indicating testing was conducted by NTPEP that supports published values may be required by member Departments.

1.3 *This work plan may involve hazardous materials, operations, and equipment. It does not purport to address all safety problems associated with its use. It is the responsibility of the user of this standard practice to establish the appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. REFERENCED DOCUMENTS

2.1 Standards for resin based material:

ASTM D 624, Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers

ASTM D 638, Standard Test Method for Tensile Properties of Plastics

ASTM D 695, Standard Test Method for Compression Properties of Rigid Plastics

ASTM D 790, Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials

ASTM D 792, Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement

ASTM D 2240, Standard Test Method for Rubber Property—Durometer Hardness

ASTM D 4060, Standard Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser

ASTM D 4541, Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers

ASTM D 7234, Test Method for Pull-Off Adhesion Strength of Coatings Using Portable Pull-Off Adhesion Testers

ASTM E 96, Standard Test Methods for Water Vapor Transmission of Materials

2.2 Standards for cementitious based material:

AASHTO-T-358, Standard Method of Test for Surface Resistivity Indication of Concrete's Ability to Resist Chloride Ion Penetration

ASTM C 109, Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens

ASTM C 266, Standard Test Method for Time of Setting of Hydraulic Cement Paste by Gillmore Needles

ASTM C 418, Standard Test Method for Abrasion Resistance of Concrete by Sandblasting

ASTM C 469, Standard Test Method for Static Modulus of Elasticity and Poisson's Ratio of Concrete in Compression

ASTM C 496, Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens

ASTM C 666, Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing

ASTM C 1090, Standard Test Method for Measuring Changes in Height of Cylinder Specimens of Hydraulic-Cement Grout

ASTM C 1583, Standard Test Method Tensile Strength of Concrete Surfaces and the Bond Strength or Tensile Strength of Concrete Repair and Overlay materials by Direct Tension (Pull-Off Method)

ASTM C 1609, Standard Test Method for Flexural Performance of Fiber-Reinforced Concrete (Using Beam with Third-Point Loading)

2.3 Standards for strength testing:

AASHTO M 242, Standard Specification for Reinforced Concrete D-Load Culvert, Storm Drain, and Sewer Pipe

AASHTO T 280, Standard Method of Test for Concrete Pipe, Manhole Sections, or Tile

ASTM D 2412, Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by parallel-Plate Loading

3. **WORK PLAN SUMMARY**

A Spray applied liner is a trenchless technology utilized to rehabilitate storm water conveyance conduits of many shapes and sizes. The liner may be applied manually or via a remote device depending on the span and rise of the host conduit. The material used in the spray application may be resinous, cementitious, or geopolymeric. Geopolymer materials will be treated as cementitious for the purpose of evaluation. Sufficient conduit cleaning, surface preparation, flow diversion, and repair of active infiltration leaks must be performed prior to placement of the spray applied liner.

Additional structural repairs may be necessary prior to the application of the spray applied liner to ensure structural integrity due to the mechanics of the soil/conduit interaction. Proper backfill support around the host conduit is paramount to the soil/conduit interaction, which must be addressed prior to application of a non-structural spray applied liner.

Cementitious and resin based spray manufacturers will be permitted to submit their products to be tested at any time during the year. Products may be evaluated for non-structural or structural applications as declared by the manufacturer. Structural liners will include all testing required for a non-structural liner in addition to testing requirements listed in Section 10. Structural liners will require the manufacturer to select the testing methodology: Method A, Method B, or both. These products are evaluated and laboratory tested by a NTPEP contracted laboratory. Test result data is entered into the web-based NTPEP *DataMine* program.

4. **SIGNIFICANCE AND USE**

4.1 This work plan utilizes laboratory testing to evaluate material used for the spray applied liner. Different laboratory material testing is required for the resin based liner versus the cementitious liner.

This work plan is intended to determine the material, durability, application properties, and the composition properties of each liner. Acceptability of each material, based upon the data generated as a result of the testing and evaluation in this practice, is the responsibility of the user. Structural design methodologies of spray applied liners are not covered under this standard practice.

5. **APPLICATION FOR PRODUCT TESTING**

5.1 Submittal of Product Evaluation Form(s) and other information.

The manufacturer will submit an electronic Product Evaluation Form (ePEF) to the NTPEP Manager through *DataMine* (<http://data.ntpep.org>). For each product submitted, the manufacturer will be asked to provide

product literature, Safety Data Sheets (SDS) information, declaration of testing for non-structural or structural applications, and payment. Structural testing will require declaration of the testing method according to: either

10.1 or 10.4. After review of the PEF(s) for completeness and accuracy, the NTPEP Manager will work with the lead state Coordinator to decide on the products to be tested. The decision will be based upon the number of total products submitted for testing by all the manufacturers and their rank order lists. The NTPEP Manager will then advise the manufacturer within two weeks of receipt of the PEF the products approved for testing.

Note 1 – At times, it may be necessary to limit the number of submittals from each manufacturer for an evaluation period to maintain a manageable work load. Any decision by the technical committee to limit submittals for a cycle will be based on the testing capacity of the contracted laboratory(s).

5.2 Assignment of Test Number

A test number shall be assigned to each product approved for testing. The test number shall indicate the Spray Applied Liner designation (SAL), the year of submission and a sequential sample number (SAL-Year-Sample No.). For example: SAL-2018-004 would be assigned to a Spray Applied Liner submitted in 2018 and was the 4th product submitted.

Note 2 – Spray Applied Liner (SAL) numbers that are assigned to a Manufacturer's product will not change for the life of the test. Once this report is submitted to the manufacturer for review, no changes to the product name will be allowed.

6. MANUFACTURER'S DOCUMENTATION

- 6.1 Upon submittal to the NTPEP, the manufacturer shall supply certified documentation showing the brand name and designation; the composition or description of the Spray Applied Liner; the SDS; and the manner in which the material will be identified.
- 6.2 The manufacturer shall indicate when this is a re-submittal, either due to a product change as described in Section 7.2 or due to the time requirements described in Section 9.
- 6.3 The manufacturer shall certify that, unless NTPEP is notified as described in Section 7.1, material furnished under the submitted brand name and designation will be of the same composition and formulation as originally evaluated by NTPEP.

7. **PRODUCT CHANGES**

7.1 Product Changes

If the manufacturer changes the formulation, composition, or alters the physical properties of a product previously evaluated by NTPEP, but maintains the same reported name, the manufacturer must notify NTPEP, regardless of whether or not they elect to re-submit the product for testing. The web-based test report will then be revised to note when a previously reported product has a new formulation which has not been evaluated by NTPEP.

Note 4 – It is recommended that users of the test data require a written certification from the manufacturer stating supplied product is identical to that most recently tested by NTPEP.

7.2 Product Changes (re-submitted)

Submitted products, previously evaluated by NTPEP and reported under the same name, but which have had formulation, composition, or concentration changes, or alterations to its physical properties, will be treated as though it were new and not previously evaluated.

8. **SAMPLING**

8.1 Furnish material samples to perform each test. Include sufficient samples to permit retesting if required.

9. INDEX AND BENCH SCALE LABORATORY EVALUATIONS

9.1 Index and Bench Scale Test Practices for Resin Based Products

Frequency of Test Years	Test	*Specifics for Test
4	ASTM D 624, Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers	Type C test method
4	ASTM D 638, Standard Test Method for Tensile Properties of Plastics	Type I specimen, thickness @0.13 inches \pm 0.02 Inches Furnish graphs for: stress vs strain, absolute strain vs applied load, and load vs extension.
4	ASTM D 695, Standard Test Method for Compressive Properties of Rigid Plastics	0.5" x 0.5" x 1" prism Furnish graphs for: stress vs strain and load vs deformation
4	ASTM D 790, Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials	3 Point, 6" span with specimen size at 3/8" x 1" x 7". Use Procedure A for Flexural Modulus and Flexural Strength Furnish graphs for stress vs strain and load vs deflection
4	ASTM D 792, Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement	Test Method A in water
4	ASTM D 2240, Standard Test Method for Rubber Property—Durometer Hardness	Type D
4	ASTM D 4060, Standard Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser	Use wheel type CS-17 at 1000 g Load with 1000 cycles
4	ASTM D 4541, Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers	Use zinc coated steel surface that has been treated with resin based spray to a thickness of 0.25 inches on one side. Use method D, E, or F tester. Test to failure or the maximum of 4000psi.
4	ASTM D 7234, Test Method for Pull-Off Adhesion Strength of Coatings Using Portable Pull-Off Adhesion Testers	Use a concrete test slab substrate with a smooth surface conforming to ISO 13007-2. Apply the resin based spray to a thickness of 0.25 inches. Test to failure.
4	ASTM E 96, Standard Test Methods for Water Vapor Transmission of Materials	Use material thickness of 0.25 inches. Perform the water method on the sample.
*Curing time for all tests to be determined by the Manufacturer.		

9.2 Index and Bench Scale Test Practices for Cementitious Based Products

Frequency of Test Years	Test	Specifics for Test
4	AASHTO-T-358, Standard Method of Test for Surface Resistivity Indication of Concrete's Ability to Resist Chloride Ion Penetration	Test at 28 days curing time
4	ASTM C 109, Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens	Test at 7 days curing time and 28 days 3 samples each test Furnish graphs for stress-strain and load vs deflection
4	ASTM C 266, Standard Test Method for Time of Setting of Hydraulic Cement Paste by Gillmore Needles	Report initial and final set times
4	ASTM C 418, Standard Test Method for Abrasion Resistance of Concrete by Sandblasting	Test at 28 days curing time
4	ASTM C 469, Standard Test Method for Static Modulus of Elasticity and Poisson's Ratio of Concrete in Compression	Test at 28 days curing time 2 4x8 cylinders Furnish graphs for stress-strain
4	ASTM C 496, Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens	Test at 7 days curing time and 28 days curing time 2 4x8 cylinders at each day
4	ASTM C 666, Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing	Test for 300 cycles, using Procedure A
4	ASTM C 1090 Standard Test Method for Measuring Changes in Height of Cylindrical Specimens of Hydraulic-Cement Grout	Test at 28 days curing time with a Relative Humidity of 90%
4	ASTM C1583 Standard Test Method for Tensile Strength of Concrete Surfaces and the Bond Strength or Tensile Strength of Concrete Repair and Overlay Materials by Direct Tension (Pull-off Method)	Test at 28 days curing time. Use a concrete test slab substrate with a smooth surface conforming to ISO 13007-2.
4	ASTM C 1609, Standard Test Method for Flexural Performance of Fiber-Reinforced Concrete (Using Beam With Third-Point Loading)	Test at 7 days curing time and 28 days curing time Test beams samples with the following dimensions: 2" x 2" x 11" (tested with 6" span)

10. STRENGTH TESTING

10.1 Strength Test Method A- D-Load Test

10.2 Baseline Concrete Pipe Structural Testing - Perform the following baseline concrete pipe structural testing once per calendar year or if the concrete pipe manufacturer changes concrete mix, source material, or pipe design.

10.2.1 Obtain 3 concrete pipes with a span of 48 inches at a commercially available length. Ensure the concrete pipes conform to AASHTO M 242 with the same specified D-load.

10.2.2 Perform three-edge bearing testing per AASHTO T 280 on all concrete pipes to determine the D-load strength and ultimate strength of the conduit. Use a constant load rate of 5,000lb/minute (± 500 lb) and provide a loading versus deflection curve. Calculate the average D-load design and average ultimate strength from the 3 concrete pipes.

10.3 Spray Applied Liner Testing - Perform the following structural testing on the initial submission of the spray applied liner or if there is a change in the product formulation:

10.3.1 Obtain 6 concrete pipes from the same vendor that supplied conduit for the Baseline Concrete Pipe Structural Testing per 10.2. Ensure the pipe has the same span, lay length, and D-load design. Verify with the vendor that no changes were made to the concrete mix, source material, or pipe design.

10.3.2 Perform three-edge bearing testing per AASHTO T 280 on all concrete pipes to determine the D-load strength of each conduit. Use a constant load rate of 5,000lb/minute (± 500 lb) and provide a loading versus deflection curve. Mark and record the orientation of the concrete pipe top and bottom.

10.3.3 The spray applied vendor or their approved contractor will perform repair of the failed conduits with either a resin or cementitious spray applied liner. Ensure the liner is applied in the same horizontal and vertical orientation as tested in 10.3.1. Apply the following thicknesses:

Concrete Test Pipe #	Cementitious Liner Thickness (inches)	Resin Liner Thickness (inches)
1	0.5	0.25
2	0.5	0.25
3	1.0	0.75
4	1.0	0.75
5	1.5	1.0
6	1.5	1.0

10.3.4 Perform three-edge bearing testing per AASHTO T 280 on all repaired specimens after a minimum curing time of 28 days. Ensure the horizontal and vertical orientation of the repaired pipe is the same as marked and recorded in 10.3.1. Determine the D-load strength and ultimate strength of the repaired conduits by identifying and measuring cracks developed in the spray applied liner. The D-load strength will be defined as

when a crack having an approximate width of 0.3-mm [0.01-in.] occurs throughout a continuous length of 300-mm \pm 25-mm [1-ft.] in the inside middle 2/3 of the pipe. Ultimate strength is defined as when the repaired conduit no longer carries a load. Monitor and record the deflection and loading. Furnish a load versus deflection curve. Use a constant load rate of 5,000lb/minute (\pm 500lb). Photograph and record any visual signs of spray liner material failure observed during the test

10.3.5 Calculate and report the percent of change between the pre-lined concrete pipe D-load strength and the repaired concrete pipe D-load strength for all repaired thicknesses.

10.4 Strength Test Method B-Parallel Plate Test

10.4.1 Perform the following testing on initial submission or if there is a change in the product formulation:

10.4.2 Obtain 4 round 36 inch span and 4 round 48 inch span removable forms or forms that lack stiffness that will interfere with the test results. Ensure the minimum length of the specimen is in accordance to Section 7 of ASTM D 2412, Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate testing.

10.4.3 The spray applied vendor or their approved contractor will apply the liner to the form according to the following:

Specimen #	Specimen Diameter (inches)	Resin Liner Thickness (inches)
1 & 2	36	0.25
3 & 4	36	0.50
5 & 6	48	0.50
7 & 8	48	0.75

The purpose of this range of diameters and liner thicknesses is to produce data from which trends may be developed so that a DOT can make informed decisions as to required thicknesses for a variety of pipe sizes and liner thicknesses. It should be recognized that if the minimum data set required by this plan does not produce reasonable trends this will not be possible.

10.4.4 Ensure the specimen is round within a 1.5% tolerance of inside or outside diameter measured at 4 points equal distance from each other around the circumference. Remove the spray applied liner from the form. Ensure removal of the form does not damage the spray applied liner. Perform a parallel-plate load tests on each specimen. Average the results and calculate the flexural modulus for each liner thickness and diameter.

10.4.5 Perform parallel plate testing according to ASTM D 2412, Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading. Take the test to 20% deflection based on the initial outside diameter of the pipe. If any damage as specified in Section 11 of the test method occurs prior to 20% deflection, the test may be stopped at that point. A plot as per Section 11.1.7 of the test method shall be required.

10.4.6 Calculate flexural modulus EI of the specimen using Appendix X.2 of the test method and using the outside diameter of the pipe.

REPORTING OF TEST DATA

11.

11.1 Test result data will be compiled and made available to all participating states and testing companies through the AASHTO/NTPEP *DataMine*. This report will include data only. No judgment as to a product's acceptability will be made in this report. End user participants will establish individual criteria for product acceptability.

11.2 Test results will be reported to the NTPEP Manager in the web-based data base – *DataMine* – as follows: Once the data is reported to the Manager, he will forward each manufacturer's data for their review. Once the manufacturer completes the review and accepts the data, the NTPEP Manager will release the data to the public.

11.3 *DataMine* – This web-based data base can be accessed through the AASHTO-NTPEP web site link at <http://data.ntpep.org>.

11.4 Timeline for Spray Applied Liner Evaluation and Reporting of Data

- Submittal package shall be maintained on the NTPEP webpage. Products can be submitted through the calendar year.
- 60 calendar days after Test start date – completion of laboratory testing.
- 65 calendar days after Test start date – completion of test results review and submission to the Lead State.
- 75 calendar days after Test start date – completion of test results review and submission to the Manufacturer.
- Results released to Public (pending manufacturer approval) within 100 days after sample test start date.
- Product listing shall be valid for three (3) years after the initial submission.

12.

TEST REPORT REVIEW AND TEST RESULT APPEALS

Each NTPEP contract laboratory will submit the *DataMine* data to the lead state Coordinator and the NTPEP Manager within 20 business days after completion of all testing. Each manufacturer will receive access to the data for their specific products. The manufacturer will review the data and may appeal the results of the testing program in accordance with the AASHTO/NTPEP appeals procedures. An appeal must be submitted within 6 months from the date of reporting by the testing facility. Re-testing of the materials will be performed by the NTPEP contract laboratory, and only on the relevant sample and parameter being questioned. No additional sample material will be received for re-testing. The contract laboratory will provide results of the re-test within 50 business days after the retest start date. Prior to re-test, the manufacturer making the appeal shall submit a fee to NTPEP to cover the costs of re-testing. Should the results of the re-test up-hold the appeal, the fee shall be reimbursed to the submitting manufacturer. Upon agreement between the manufacturer appealing the test results and the NTPEP Manager, either the original set or re-test set of data shall be published.

13.

RESUBMITTAL TESTING FREQUENCY

Resubmittal of a previously tested product must be accomplished within the testing frequency outlined in Section 9. If resubmittals have not been received by the end of the testing frequency time frame, then the product will be removed from *DataMine*.

The manufacturer may elect to resubmit products earlier for full testing to fulfill member state's requirements to be maintained on their qualified products list (QPL).

TESTING FEES

14.

Testing fees are to be paid at time of application. Fees paid by the manufacturer will not be refunded once testing begins.

Note 4 - A re-test fee for challenged results shall be paid by the manufacturer. This fee is refundable if retesting upholds the challenge. Fee is to be paid only if the original test results are found to be accurate.

15. **KEYWORDS**

Spray Applied Liner; *DataMine*; NTPEP