

POLYURETHANE LINING AND COATING ON DUCTILE IRON PIPE

PART 1 -- GENERAL

1.1 THE REQUIREMENT

- A. The CONTRACTOR shall provide pipe coating, complete and in place, in accordance with the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

AWWA C216	Heat-shrinkable Cross-linked Polyolefin Coatings for the Exterior of Special Sections, Connections, and Fittings for Water Pipelines
NACE SP-0188	Discontinuity (Holiday) Testing of Protective Coatings
ASTM G14	Standard Test Method for Impact Resistance of Pipeline Coatings (Falling Weight Test)
ASTM D522	Standard Test Methods for Mandrel Bend Test of Attached Organic Coatings
ASTM D4541	Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers
ASTM E96	Standard Test Methods for Water Vapor Transmission of Materials
ASTM D2240	Standard Test Method for Rubber Property—Durometer Hardness
ASTM G95	Standard Test Method for Cathodic Disbondment Test of Pipeline Coatings (Attached Cell Method)
ASTM D4060	Standard Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser
ASTM D570	Standard Test Method for Water Absorption of Plastics
NAPF 500-03-01	Solvent Cleaning
NAPF 500-03-02	Hand Tool Cleaning
NAPF 500-03-03	Power Tool Cleaning

NAPF 500-03-04 Abrasive Blast Cleaning for Ductile Iron Pipe

NAPF 500-03-05 Abrasive Blast Cleaning for Cast Iron Fittings

ASTM D16 Standard Terminology Relating to Paint, Varnish, Lacquer, and Related Products

1.3 CONTRACTOR SUBMITTALS

- A. General: Submittals shall be furnished in accordance with this specification, unless indicated otherwise below.
- B. Submittals shall include the following information and be submitted at least 30 days prior to coating the pipe.
 - 1. Manufacturer's data sheet for each product proposed, including Statements on the suitability of the material for the intended use.
 - 2. Technical and performance information that demonstrates compliance with the system performance and material requirements.
 - 3. Manufacturer's instructions and recommendations on surface preparation and application.
 - 4. Colors available for each product (where applicable).
 - 5. Compatibility of shop and field applied coatings (where applicable).
 - 6. Material Safety Data Sheet for each product.

1.4 QUALITY ASSURANCE

- A. Coating Applicator's Experience and Certification
 - 1. Coating application personnel, whom have direct spray application responsibility, shall be certified by the manufacturer of the selected product.
 - 2. The coating applicator shall demonstrate that they have, at a minimum, 3 years experience in the preparation and application of coatings on ductile iron pipe and fittings.

1.5 DEFINITIONS

- A. DFT: Minimum Dry Film Thickness, without any negative tolerance.

1.6 ABBREVIATIONS

MDFT	Minimum Dry Film Thickness
Mil	Thousandths of an Inch

PART 2 -- PRODUCTS

2.1 GENERAL

- A. Coating materials shall be standard products produced by recognized manufacturers who are regularly engaged in production of such materials for essentially identical service conditions. Products must have five (5) years of case histories on similar ductile iron pipe coating projects.
- B. Pipeline coating materials shall be the products of a single manufacturer, unless otherwise noted in this specification. Product substitutions during the project will not be considered or permitted.
- C. Coating applicator shall provide a monitoring system approved by the coating manufacturer that constantly records pipe and coating conditions during coating application. Recorded monitoring parameters shall include pipe temperature, line speed, surface preparation, holiday test and other parameters applicable to the type of coating.
- D. Substitute or "Or-Equal" Products for Coating Systems
 - 1. The CONTRACTOR shall furnish satisfactory documentation from the manufacturer of the proposed substitute or "or-equal" product that the material meets the requirements of this specification as listed in section 2.1 and 2.2.
 - 2. If a proposed substitution requires changes in the WORK, the CONTRACTOR shall bear all such costs involved, as part of the WORK.

2.2 POLYURETHANE SYSTEM

- A. General: Pipe, fittings, and specials shall be lined and coated with polyurethane complying with section 2.2 B. Surfaces in contact with potable water shall receive a coating, which is certified under NSF Standard 61.

- B. Material: The coating material shall be a two-component, fast set, Type V polyurethane according to ASTM D 16 - Standard Terminology Relating to Paint, Varnish, Lacquer, and Related Products. Solids content shall be no less than 100 percent by volume.
1. Manufacturers, or equal
 - a. LifeLast Inc., Vancouver, WA. DuraShield 110, DuraShield 210 or DuraShield 310.
- C. Product acceptance is contingent upon:
1. Submission of an independent testing report documenting conformance to the coating performance criteria specified herein.
 2. Verification that no significant change in product formulation has occurred since independent test was performed.
- D. Coating Performance Testing and Report
1. Coating manufacturer shall submit to the Engineer for approval, test reports documenting conformance to the specified performance criteria using prepared samples and coating materials conforming to the following general requirements:
 - a. Polyurethane coating material tested shall have been manufactured within 30 days of test sample preparation.
 - b. Coating material to have a minimum of five years prior ductile iron pipeline coating application history.
 - c. Extended polyurethane coatings will not be acceptable.
 2. Submission of incomplete reports, use of test procedures or methods other than those specified, or preparation of samples with coating material other than those listed will result in rejection of the coating.
 3. Reports shall be submitted for review and approval not less than 30 days prior to coating application along with current product data sheets and MSDS sheets for Parts A and B.
 4. Test Sample Preparation:
 - a. Failure to fully conform to the preparation requirements will result in rejection of the submitted coating material.

- b. Sample preparation completed by the coating manufacturer shall be fully documented and reported to the testing agency by the manufacturer.
 - c. All coating test samples shall be prepared in conformance with the following general requirements.
 - d. Sample Surface preparation:
 - 1) Method: Abrasive blast, steel grit or green diamond, SSPC-SP-10.
 - 2) Profile: 3.00 mils, minimum, angular profile, measured and recorded using surface profilometer or surface replica tape.
 - e. Coating Application:
 - 1) Method: Spray film in accordance with manufacturer's written shop application requirements. Thickness: 30 to 50 mils.
 - 2) Cure: Air cure only, oven or other accelerated cures will not be acceptable.
 - 3) Form: Sheet, steel panel, or steel pipe as required for the test procedure.
 - f. Sample Quantity: Provide a minimum of three samples for each test performed or as required by the ASTM test standards, whichever is more stringent.
6. Coating Tests and Criteria:
- a. Testing shall be performed by a certified independent laboratory testing agency with a minimum five years experience in the performance of ASTM test procedures on coating systems.
 - b. All testing shall be at room temperature, unless specifically required otherwise by the ASTM test procedure.
 - c. Material property test requirements are listed in the table below:

Property	Requirement
Impact Resistance	No less than 125 inch-pounds when tested according to ASTM G14 for 40 mil thickness
Flexibility	No cracking observed when tested according to ASTM D522 using a 3" Mandrel
Adhesion	No less than 1500 psi when tested according to ASTM D 4541
Hardness	75 (plus or minus 5) Shore D, at 70 degrees F, when tested according to ASTM D2240
Cathodic Disbondment	Less than 8 mm at -3.00 volts potential when tested according to ASTM G 95 for 30 days
Abrasion Resistance	Less than 50 mg weight loss per 1000 revolutions of a CS-17 wheel, 1 kg weight, when tested according to ASTM D4060
Water Absorption	Less than 1 percent by weight when tested according to ASTM D570
Dielectric Strength	No less than 200 volts per mil of coating

7. Reporting:

- a. As required by the ASTM test method and the following additional information:
 - 1) Sample panel preparation date and identification
 - 2) Surface preparation method and abrasive
 - 3) Surface preparation profile
 - 4) Coating lot and date of manufacture
 - 5) Application spray gun and equipment used
 - 6) Application temperatures of coating materials and material temperature at the gun, ambient temperature, and panel surface temperature.
- b. Show all calculations as required by the ASTM test method.
- c. Submit report in PDF format.

E. Thickness:

Interior of pipe and fittings-Low Flow	60 mils DFT, minimum
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Interior of pipe and fittings-Pressure	40 mils DFT, minimum
Exterior pipe and fittings	40 mils DFT, minimum
Sealing areas on bells and spigots	8-mils DFT. Thicker coating which does not compromise joint tightness may be accepted.

2.3 EXTERIOR FIELD JOINT COATING

- A. Buried: Field joints shall be coated with heat shrink sleeves per AWWA C216 or as specified by the engineer.
- B. Above Ground
 - 1. Manufacturers, or equal
 - a. LifeLast Inc. DuraShield 110, DuraShield 210, DuraShield 310, or DuraShield 310 JARS (Joint and Repair System).
 - 2. Field contractor must provide a letter from the coating system manufacturer stating they have been approved as an applicator.
 - 3. Coating applicator that does not meet the qualifications requirements may be rejected by Construction Manager.

2.4 REPAIR OF COATINGS AND LININGS

- A. General
 - 1. Coating or lining repair materials shall be compatible with the shop-applied coating or lining system.
- B. Field Repair Coating Materials
 - 1. Polyurethane Coating or Lining
 - a. Polyurethane coating or lining system repair shall be in accordance with the coating manufacturer's recommended procedures.
 - b. Coating material for minor repairs shall be single use kits or other mix ratio controlled systems of slow set polyurethane coating material similar to the existing coating or approved by the coating manufacturer.

- c. Major repairs, those exceeding one square foot of surface area, will be completed using the same coating material as for the coating or the lining. Surface and adjacent coating shall be abrasively blasted to meet the original coating specifications and to properly roughen the adjacent coating. Coating shall be reapplied using plural component spray equipment by a manufacturer-certified coating applicator.
- 2. Curing of Field Applied Coatings
 - a. All field-applied coatings shall be completely cured prior to installation.

PART 3 -- EXECUTION

3.1 WORKMANSHIP

- A. Skilled manufacturer, trained craftsmen and experienced supervision shall be used to perform the application. Spray application of the polyurethane, requires certification by the manufacturer, of the individual applicators.

3.2 STORAGE AND MIXING OF MATERIALS

- A. Manufacturer's Recommendations: Unless otherwise indicated, the coating manufacturer's printed recommendations and instructions for thinning, mixing, handling, applying, and protecting its coating materials, for preparation of surfaces for coating, and for all other procedures relative to coating shall be strictly observed.
- B. Materials shall be used within the manufacturer's recommended shelf life.
- C. Storage and Mixing: Materials shall be stored and mixed per the manufacturers recommendations.

3.3 SURFACE PREPARATION

- A. Pipe shall be clean and free of contaminants. If not, the pipe surfaces shall be cleaned in accordance with NAPF 500-03-01, to remove oil, grease, and other soluble contaminants. No residue shall remain on the pipe. Remove burrs and gouges.
- B. Prepare the metal surface to achieve a metal finish and cleanliness in accordance with NAPF 500-03-04 and/or NAPF 500-03-05, application dependent, ductile or cast iron to an angular profile of

3.00-mil, minimum, measured and recorded using surface profilometer or surface replica tape.

- C. In the event that blasting leaves slivers and/or delamination, these areas must be ground smooth and re-blasted.
- C. Pipe temperatures shall be at least 5 degrees F warmer than the dew point temperature and within the coating manufacturers recommended temperature range per the technical data sheet. Pipe shall be warmed if necessary.
- D. Pipe shall not be allowed to flash rust before coating is applied.

3.4 APPLICATION

- A. Apply the coating in strict conformance to the manufacturer's recommendations.
- B. Recoating shall be performed in strict conformance to the manufacturer's recommendations.

3.5 FACTORY TESTING

- A. Coating Appearance.
 - 1. All coated pipe shall be visually inspected. The coating shall be generally smooth and free of sharp protrusions. A minor amount of sags, dimpling, scuffing, and curtaining that does not exceed 10 percent of the surface shall not be considered cause for rejection.
 - 2. The coating shall have no blisters, cracks, bubbles, delamination, or any other visible defects. There shall be no wet or sticky areas in the coating.
 - 3. All imperfections shall be identified and repaired according to Sec. 2.4.
- B. Dry Film Thickness
 - 1. Dry film thickness shall be measured in accordance with SSPC-PA 2 to ensure compliance with Sec. 2.2 E. If the thickness is found to be less than the amount required, all of the pipe coated since the last thickness measurement shall be checked and over-coated if necessary.
- C. Electrical Continuity Inspection.
 - 1. Electrical continuity inspection shall be conducted in accordance

with NACE RP-0188 any time after the coating has reached sufficient cure, but prior to installation.

2. The voltage setting shall be per manufacturer's recommendation except that the minimum shall be 100 v/mil.
3. Any holidays indicated by the detector shall be marked and repaired per Sec. 2.4.

D. Adhesion Testing

1. The adhesion will be considered satisfactory if the test value is a minimum of 1,500 psi.
2. Adhesion testing shall be conducted on two sufficiently cured, coated sections of pipe from each shift selected at random with one from the beginning of the shift and one from halfway through the shift.
3. Adhesion testing shall be conducted in accordance with ASTM D4541, using Delfesko Positest AT-A automatic pneumatic pull off tester and 14mm dollies.
4. Adhesion testing records shall include pipe identification, surface tested (interior or exterior), surface temperature, coating thickness, tensile force applied, mode of failure, and percentage of substrate failure relative of dolly surface.
5. Dollies for adhesion testing shall be glued to the coating surface and allowed to cure for a minimum of 12 hours. Because of high cohesive strength, polyurethane coatings shall be scored around the dolly prior to conducting the adhesion test. Extreme care shall be taken when scoring around the dollies.
6. Failure shall be by adhesive and cohesive failure only. Adhesion failure is defined as separation of the coating from the steel substrate. Cohesive failure is defined as failure within the coating, resulting in coating remaining both on the steel substrate and dolly.
7. Partial adhesion and glue failures will be retested if the adhesion failure is less than 50 percent relative of the dolly surface area and the applied tension was less than the adhesion criterion. Pipes that have partial adhesion failures greater than 50 percent and less than the required adhesion will be rejected as a substrate adhesion failure.
8. Adhesion tests will be conducted on polyurethane pipe coating and

lining independently and will be accepted or rejected independently of the other.

9. If the adhesion is not satisfactory, two additional tests shall be made at two different locations on the same pipe. If either additional test fails, the pipe shall be rejected. If the pipe is rejected, a systematic inspection of all pipe coated on that shift shall be made, and all pipe not meeting this adhesion requirement shall be rejected. Damaged test areas of accepted pipe and areas determined to have unsatisfactory adhesion shall be repaired in accordance with Sec. 2.4.

3.6 FIELD INSTALLATION

- A. Pipe shall be handled at all times to minimize damage to the lining and coating. Damaged lining and coating shall be repaired.
- B. Repair of Damaged Areas.
 1. Test the pipe after installation for holidays per NACE SP-0188. Mark holidays and repair per the manufacturers recommendations.
 4. Use only material recommended by the manufacturer for repair.

3.7 REPAIR OF COATING AND LININGS

- A. General
 1. Areas where holidays are detected or coating is visually damaged, such as blisters, bubbles, cuts or other defects shall be repaired.
- B. Polyurethane Coating or Lining Repairs
 1. General
 - a. Complete coating repairs in accordance with the coating manufacturer's written instructions and these Specifications, whichever is stricter.

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