



Coated Products

Plant Applied External Fusion Bond Epoxy Pipe Coating

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COATED PRODUCTS SPECIFICATIONS

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1. GENERAL

This specification covers the minimum requirements for materials, application and testing of plant-applied external fusion bonded epoxy (FBE), both single and multi-layer (abrasion-resistant overlayer), pipe coating.

2. DEFINITIONS

- 2.1 "Company" — End User
- 2.2 "Contractor" — Coating Applicator
- 2.3 "Manufacturer" — Pipe Manufacturer
- 2.4 "Coating Powder" — The firm from which the Contractor obtains coating Manufacturer powder for application on Company's pipe.
- 2.5 "Purchase Order" — The Purchase Order to which this specification is made an attachment and to which this specification is incorporated by reference.

3. QUALIFIED MATERIALS

Powders listed have been tested and approved by the Contractor. Other powders will be added as they are tested and approved.

- 3.1 3M: Scotchkote 206N, Scotchkote 6233, Scotchkote 207R, Scotchkote 6352*
- 3.2 Dupont: Napgard 7-2500, Napgard 7-2501, Napgard 7-2502, Napgard 7-2508, Napgard 7-2502 NS, Napgard 7-2610*
- 3.3 Valspar: Pipeclad 2000, Pipeclad 2040*
- 3.4 Jotun: EP-F1010, EP-F3002*
- 3.5 BASF: PE 50-1080, PE 50-1081, PE 50-1200*

* ARO Powders

4. COATING MATERIAL QUALIFICATIONS

- 4.1 Full cure of coating shall be achievable at temperatures below 500° F.
- 4.2 Coating shall withstand 15 inch pounds of impact per NACE International RP0394, latest edition.
- 4.3 Coating shall withstand bending of 2.5 degrees per pipe diameter (Deg./PD) at 0° F.
- 4.4 Coating shall have sufficient weather resistance to withstand prolonged exposure to ultraviolet rays equivalent to 5 years of actual atmospheric exposure, in a high humidity, severely chloridic environment.
- 4.5 Coating shall not ignite, blister or burn back more than 2 inches when pipe is welded or cut with a cutting torch.
- 4.6 Coating shall not deform, deteriorate or disbond when exposed to soil stresses at temperatures up to 175° F.
- 4.7 Coating will be able to withstand continuous operating temperatures of 250° F without showing any signs of cold flow.

5. PLANT REQUIREMENTS

The following equipment requirements are prerequisites for application of coating; all plant equipment must be in good working condition.

- 5.1 Plant shall have a detailed standard coating procedure documented and available to Company.
- 5.2 Plant shall have an operational preheater to remove moisture prior to final blasting.
- 5.3 Plant shall have a mid-plant kick out system to divert rejected pipe or pipe requiring heavy grinding from the coating line.
- 5.4 Any air lines supplying air knives or lances which impinge air on the bare pipe shall use only dry air having a minimum dew point temperature reading of -20° F measured at the air dryer.
- 5.5 All runners and conveyors shall be kept in adequate condition to prevent contamination to pipe, or damage to pipe or coating.
- 5.6 The powder system shall have a source of clean and dry air. The dew point of the air in the fluidized bed and powder feed lines must be no higher than -20° F measured at the air dryer.
- 5.7 Fluidized beds will have magnets adequate to remove iron and steel contamination from virgin and recycled powder.
- 5.8 Powder system shall have an automatic fire shutdown system.
- 5.9 Coating material shall be stored in a temperature controlled storage room.
- 5.10 All plants shall have a fully equipped laboratory consisting of the following test equipment for quality control:
 - A. Power saw for cutting coated pipe test panels.
 - B. Refrigeration equipment which can achieve -40° F.
 - C. A strap bending apparatus of either the four point or mandrel type.
 - D. Microscope of at least 40X power.
 - E. Equipment for Cathodic Disbondment Testing in accordance with the applicable section(s) of NACE International RP0394, latest edition.

- F. Measuring equipment for coating thickness, pipe temperature, and anchor pattern profile.
- G. Ultrasonic thickness gauge, with steel calibration block approximating the thickness of pipe to be coated.
- H. General purpose water bath.
- I. Convection oven.
- J. Electrostatic spray equipment.
- K. Blast cabinet for preparation of lab panels.
- L. Pipe beveling equipment.
- M. D.S.C. (Differential Scanning Calorimeter).

6. HANDLING AND STORAGE OF COATING MATERIAL

- 6.1 All powders are ordered certified to CAN/CSA Z245.20-98.
- 6.2 Gel tests are performed on all batches of powder received per CAN/CSA Z245.20-98.
- 6.3 Powder is stored in a climate controlled storage room per coating powder manufacturer's recommendations.
- 6.4 Powder is segregated and consumed on a first truckload in/first truckload out basis.
- 6.5 Batch traceability is achieved by the recording of batch numbers on the daily production tally sheets at the time batches are introduced into the coating system.

7. UNLOADING, HANDLING AND STORAGE OF BARE PIPE

- 7.1 Pipe shall be inspected upon arrival. When damaged pipe is found, trucks or rail cars are not to be unloaded until exception is noted on the bill of lading and/or the transporter's representative has inspected the load.

Damaged pipe found during unloading shall be segregated and the supplier of the pipe will be notified immediately for resolution.

- 7.2 Forklift or crab forks need not be padded for handling of bare pipe, but they must be free of burrs or projections that could gouge or scratch pipe, and free of oil, lacquer, etc. that could contaminate pipe surface.
- 7.3 Pipe will be stored on wood racks that are free of debris or projections (e.g., gravel, exposed nails) that could damage the pipe.
- 7.4 Stacking height of pipe 12" to 14" will be limited to eight (8) high. Pipe 16" to 18" will be limited to six (6) high. Pipe 20" will be limited to five (5) high. Pipe 22" to 24" will be limited to four (4) high unless approved by owner.

8. SURFACE PREPARATION AND CLEANING

- 8.1 Oil or grease shall be removed by suitable non-oily solvent per SSPC SP-1. Pipe with lacquer will be heated and wire brushed cleaned prior to blasting.
- 8.2 All pipe shall be preheated before blasting.
- 8.3 Centrifugal blasting machines shall be used, one with steel shot and one with grit. Abrasive used shall provide a surface suitable for coating.
- 8.4 Pipe bevels and the I.D. will be protected from abrasive blast and impact damage at all times.
- 8.5 The surface to be coated shall be cleaned to a SSPC-SP-10 "NearWhite" finish and the anchor pattern profile will be at least 2.0 mils and no more than 4.0 mils.
- 8.6 The surface shall be inspected immediately after blasting, and all slivers, scabs, and detrimental gouges made visible by cleaning shall be removed.
- 8.7 Any anchor pattern removed by excessive grinding shall be reblasted before coating. Excessive grinding is defined as either: 1) any continuous ground area of more than 0.5 sq. ft., or 2) a cumulative ground area of more than 2 sq. ft./length of pipe.
- 8.8 Pipe which has flash rusted or has not been coated within 4 hours after cleaning shall be completely reblasted before processing.
- 8.9 All blasting abrasive shall be removed from the pipe interior prior to coating.

9. COATING APPLICATION

- 9.1 Pipe that has been abrasive blast cleaned and inspected shall be heated to a temperature in accordance with coating powder manufacturer's data sheet.
- 9.2 The specified pipe temperature range shall be maintained as the pipe enters the FBE coating spray booth and shall be strictly monitored. The use of tempil sticks and/or pyrometers is satisfactory.
- 9.3 Fluid bed magnets shall be inspected and cleaned prior to startup.
- 9.4 Coating shall be applied to the specified thickness in one pass through the coating booth.
- 9.5 The finished coating shall have a cutback measured from the bevel shoulder of 1.5 to 3 inches. Cutbacks and bevels, as well as any internal surface within 0.5 inch of the land, shall be free of any coating.

10. MULTI-POWDER AND ABRASION RESISTANT OVERLAY (ARO)

- 10.1 The powders will be sprayed using two separate spray booths.
- 10.2 Powder from the topcoat shall not be recycled into the base coat powder.
- 10.3 The ARO FBE topcoat shall be applied in accordance with the coating powder manufacturer's recommended procedure and prior to gelling of the FBE corrosion base coat.
- 10.4 The minimum coating thickness shall be specified by the Company. The respective thicknesses of the base coat and the top coat shall be measured with a Tooke gauge.

11. INSPECTION: PRODUCTION COATING

- 11.1 It is the responsibility of Quality Control to advise the Plant Manager, Assistant Plant Manager, or Corporate Quality Manager when conditions exist which adversely affect the quality of the external coating operation with respect to cleaning, application or material performance. Corrective measures are to begin immediately.
- 11.2 The following requirements for testing externally coated pipe will be strictly observed.
 - A. Coating thickness checks shall be made at 200° F or below with a dry film thickness gauge, which has been calibrated previously using a National

Institute of Standard and Technology (N.I.S.T.) nonmagnetic coating standard with a thickness within 20% of the specified coating thickness. A minimum of five coating thickness measurements shall be taken on each length of pipe.

- B. Any length of pipe having less than the specified minimum thickness shall be completely recleaned to the originally specified surface, and recoated.

11.4 HOLIDAY DETECTION

- A. Jeeping (holiday detection) shall be done inline or manually.
- B. Jeoper shall contact all coated pipe surface, including the weld toe area.
- C. The holiday detector shall be operated at a minimum of 125 volts per mil of coating.
- D. The maximum allowable holiday density on any length of pipe having a diameter equal to or greater than 10.75 inches is one holiday per 25 sq. ft. of pipe surface.
- E. For pipe having a diameter of less than 10.75 inches, the maximum allowable holiday frequency is one per 10 feet of pipe.
- F. Cured coating shall be of uniform color, gloss, and thickness and shall be free of blisters, pinholes, craters, fish eyes, sags, or other detrimental irregularities.

12. QUALITY CONTROL: PRODUCTION RING TESTS

All testing performed by Contractor shall be started within 24 hours after the start of production, unless an agreement is made between Contractor and Company or Company's representative prior to beginning production.

The following destructive tests will be performed on one pipe from each lot of coated pipe of the same diameter and wall thickness. Failure of any test constitutes rejection of all coating applied after the last test pipe with acceptable results, and before the next test pipe with acceptable results. Lot narrowing will be used to identify unacceptable product.

Ring samples cut from test pipe shall be approximately 18 inches long. After samples are cut from the ring, the date of coating applications will be marked on the unused portion of the ring sample.

12.1 **Bend Tests** shall be performed on duplicate longitudinal straps at 0° F. Either the mandrel method or the four-point bend method shall be used. Bends shall be examined under microscope at a minimum of 40X. Any tear or crack in the coating constitutes a failure, unless located within 0.1 inch from the edge of the strap.

- A. Mandrel bend tests shall be performed with an acceptance criteria of 2.5° / PD total deflection at 0 ° F.
- B. Coating shall withstand a permanent strain of 1.5 ° /PD, as determined by measurement of strap curvature after bending by matching to drawn arcs of known radii, as established in NACE RP0394 latest edition.

NOTE: Bend tests are not applicable to ARO coated samples.

12.2 **Cathodic Disbondment Tests** shall be performed on a 4 inch square test panel for 24 hours, with 3 1/2 volts at 150° F (electrolyte temperature) using 3% salt solution. The time, voltage and temperature shall be checked and recorded. Coating shall not disbond more than 8 mm in radius from an initial 3 mm diameter holiday.

12.3 **Contamination And Porosity Tests.** Coating chips shall be removed by bending a strap from each ring at low temperature, and examined with a 40X microscope. The coating chips are subject to the following acceptance criteria.

- A. Contamination on the underside of coating chips shall not exceed 30% of the surface area.
- B. The outermost 40% of the coating thickness shall be essentially free of porosity, excluding isolated pores. Alternatively, porosity distribution shall have a void rating of 3 or less, as determined per NACE RP0394 latest edition.

Foam bond or cellular porosity will not be tolerated. "Foam bond" is a condition resembling soap bubbles on the steel surface, where only thin membranes of coating separate the pores. Generally, such a condition will permit easy gouging and stripping of the coating with a simple knife test.

12.4 **Moisture Permeation Tests** shall be performed by immersion of a 4-square inch sample at 150° F in tap water for twenty-four (24) hours. The coating shall then be physically examined by scribing a rectangle with a knife through the coating to the pipe substrate. Coating within scribed area shall be rated a 3 or less as per NACE RP0394 latest edition.

Evaluation shall be made in terms of the following rankings:

Rating 1: Coating cannot be removed cleanly.

Rating 2: Less than 50% of the coating can be removed.

Rating 3: 50% or more the coating can be removed, but the coating demonstrates a definite resistance to the levering action.

Rating 4: The coating can be easily removed in strips or large chips.

Rating 5: The coating can be complete removed as a single piece.

The results from the permeation test should be a 3 or less.

13. TRACKING, STENCILING AND RECORD KEEPING

- 13.1 All internal manufacturer's stencils shall be maintained, including length and joint/heat identification. Where such stencils are defaced by blasting operations or couplings, appropriate record keeping shall be maintained to assure that stencil information is correctly replaced.
- 13.2 After coating, unless otherwise requested by Company, marking per API requirements including the following information shall be marked on each pipe:
 - A. Purchase Order number, if requested
 - B. Pipe size and grade
 - C. Date coated
 - D. Coating sequence number
 - E. Applicator
 - F. Coating manufacturer
 - G. Company name, if required
- 13.3 Contractor will provide the Company's representative daily production tallies which contain the following information:
 - A. Date and coating sequence number
 - B. Manufacturer's joint/heat number (required only for X-grade pipe of diameter 10.75 inches or larger)
 - C. Joint length
 - D. Coating thickness
 - E. Jeep count
 - F. Disposition [accepted, rejected for stripping and recoating, or temporarily rejected (e.g., diverted for cut-off, rebeveling, coating repairs that cannot be made at time of final inspection, etc.)].
- 13.4 Pipe that is temporarily rejected shall be shown on a non-prime report. The repairs will be approved by Quality Control.

14. REPAIRS TO COATING

14.1 FBE SINGLE LAYER REPAIRS

- A. All defects disclosed by the holiday detector and defects resulting from mechanical damage to the coated surface shall be repaired.
- B. Damaged coating areas and holidays shall be cleaned by removing rust, scale, loose coating, dirt, or other foreign materials. The area immediately surrounding the repair shall also be suitably roughened, feathered and cleaned for proper adhesion of repair materials.

B. Small Defects and Pinholes

Repairs less than 1 sq.in. will be repaired with a patch stick. The patch-stick material shall be applied in accordance with the coating powder manufacturer's recommended procedure.

B.2 Large Area Defects

The maximum total surface area of exposed steel that may be repaired by patching is 2 sq.ft. (cumulative area per double random length), or a maximum of .25 % of the cumulative surface area per joint. Additionally, no single repair may exceed 10 inches in length or a total of 36 sq.in. Patching in excess of these limits is permissible only with the specific acceptance of the Company.

Coating powder manufacturer's recommended 100% solid, catalytically-cured, two part liquid epoxy shall be used for patching holidays and damaged coating.

Patched areas shall overlap the surrounding undamaged coating by a minimum of 0.5 inch.

14.2 ARO REPAIRS

- A. Defective and damaged coating shall be suitably roughened and patched area shall overlap the surrounding undamaged coating by _ inch.
- B. Contractor shall apply Coating powder manufacturer's recommended repair material per the Coating powder manufacturer's recommended procedures.
- C. All repairs are inspected with a portable holiday detector.

- D. Repair of other multilayer coatings shall be in accordance with the coating Coating Powder Manufacturer's recommended procedures.

15. PADDING AND HANDLING OF COATED PIPE

15.1 Separators

Before handling, protective separators shall be attached to each joint. Separators shall be of the loop type or other Company approved material. 15.2

Acceptable Separators

The following types of separators are permitted. Separators are subject to the approval of the Company.

- A. Rope, polypropylene, tight weave, 3/8 inch diameter
- B. Rope, polypropylene, tight weave, 1/2 inch diameter
- C. Rope, polypropylene, tight weave, 5/8 inch diameter
- D. Rope, polypropylene, tight weave, 3/4 inch diameter

15.3 Number of Separators

There shall be one separator for each increment of pipe length (or fraction thereof), as given in the following table. In no case shall any length of pipe have fewer than 3 separators. Coated pipe destined for barge load out is subject to special requirements, dependent on loading arrangement.

PIPE DIAMETER	MAXIMUM NOMINAL WEIGHT/FOOT OF PIPE	SEPERATOR TYPE	MAXIMUM INCREMENTAL DISTANCE BETWEEN SEPERATORS
Up to 6 5/8 inches	ALL	A,B,C,D	15 feet
ALL	<30 lb./ft	A,B,C	13 feet 15 feet 15 feet
ALL	31—70 lb./ft.	B,C,D	8 feet 15 feet 15 feet
ALL	71—100 lb./ft	B,C,D	5 feet 10 feet 15 feet
ALL	101—150 lb./ft	C,D	7 feet 15 feet

- 15.4 Separators shall be evenly spaced along the pipe and shall be applied to pipe before interim storage and load-out. Outermost separators shall be within 2 feet of pipe ends.
- 15.5 Pipe shall be handled, loaded and stacked in a manner to prevent damage to pipe wall, beveled ends, and both internal and external coating.
- 15.6 Coated pipe shall be stored on solid wood timbers. Timbers shall be free of any gravel, nails, grit, or other material which could damage the pipe or coating.
- 15.7 Padding of equipment forks used in handling coated pipe shall be dense rubber or polyurethane padding at least 3/16 inch thick.

16. LOAD-OUT REQUIREMENTS

No product shall be dispatched until the Company specified requirements and quality system requirements have been completed, and the associated data and documentation are available and authorized. When Company specified requirements allow for release of product prior to test completion, allowance shall be made for recall in the event of nonconformance.

- 16.1 Each pipe shall have the required number of separators as specified in Section 15.
- 16.2 Dunnage shall be made from hardwood. Nails in the pipe contact area shall be countersunk a minimum of 1/8 inch. Nails that are located well away from a pipe contact area (such as the backside of an end chock) are not required to be countersunk.
- 16.3 Taping of end separators to pipe shall be the method used to avoid loss of separators in transit.
- 16.4 Loading equipment forks shall be equipped with dense rubber or polyurethane padding.
- 16.5 Product released prior to completion of laboratory testing shall have a means of positive recall in the event of a test failure.