Specification for Concrete Weight Coating
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1.0 SCOPE

This specification shall govern the materials, application, inspection, repairs, handling and other requirements for external concrete weight coating of pipe. The work includes the furnishing of all labor, materials, tools and equipment and the performance of all operations and incidentals necessary for the coating, handling, storing and shipping of coated pipe.

For the purposes of this specification, the following definitions apply:

COMPANY: The firm responsible by contract for the application of the concrete weight coating to the pipe.

CONTRACTOR: Signed work agreement between COMPANY and CONTRACTOR.

CONTRACTOR shall obtain COMPANY's written approval for any deviations from the requirements of this specification or specifications, standards and drawings referenced herein or elsewhere in the CONTRACT. In case of conflict between documents, the order of precedence given in the CONTRACT shall govern.

This document is not intended to be all inclusive, and the use of the requirements set forth does not relieve the CONTRACTOR of his responsibility to supply a product capable of performing its intended service.

2.0 REFERENCE DOCUMENTS

The coating shall be applied in accordance with the latest editions and addenda of the following codes and standards.

American Society for Testing and Materials

ASTM A82 Specification for Steel Wire, Plain, for Concrete Reinforcement

ASTM A90 Test Method of Weight of Coating on Zinc - Coated (Galvanized) Iron or Steel Articles

ASTM A185 Specification for Steel Welded Wire, Fabric, Plain, for Concrete Reinforcement

ASTM A641 Specification for Zinc-Coated (Galvanized) Carbon Steel Wire

ASTM C31 Standard Method of Making and Curing Concrete Test Specimens in the Field

ASTM C33 Standard Specification for Concrete Aggregates

ASTM C39 Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens

ASTM C150 Standard Specification for Portland Cement

ASTM C309 Specification for Liquid Membrane - Forming Compounds for Curing Concrete

ASTM C642 Test Method for Specific Gravity, Absorption, and Voids in Hardened Concrete

American Petroleum Institute

API SPEC 5L Specification for Line Pipe

2.1 COMPANY Specifications

2136600-SP-016 Sacrificial Anodes – Installation to Pipe

2136600-SP-017 Pipe Handling and Storage

2136600-SP-018 Corrosion Prevention Coating – Coal Tar Enamel

3.0 MATERIALS

All concrete coating materials shall be furnished by the CONTRACTOR and shall consist of Portland
cement, aggregate, reinforcing steel and water. These materials shall conform to the following specifications.

3.1 Cement

Cement shall conform to ASTM C150, Type II, or approved equal and shall be stored in a manner that will satisfactorily protect it from the elements. Cement that has hardened, partially hardened, or become lumpy shall not be used. Test certificates from the cement manufacturer shall be presented to the COMPANY for all cement.

3.2 Water

Water shall be clean and free from injurious amounts of oil, acid, alkali, salt, organic material or other deleterious substances. Seawater or water from stagnant swamps or excavations shall not be used. The COMPANY reserves the right to require the CONTRACTOR to test the water and have the results approved by the COMPANY prior to its use in the concrete mixture.

3.3 Sand (Silica Type)

Sand used shall be round grained and shall be obtained by sieving. It shall be free of injurious amounts of salt, alkali, deleterious substances or organic impurities. Suitability of the natural sand for making concrete shall be determined in accordance with the requirements of ASTM C33. The sand shall be well graded to the following sieve sizes:

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<tr>
<th>U.S. Standard %</th>
<th>Sieve Size</th>
<th>Passive</th>
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<tr>
<td></td>
<td>3/8 in.</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>No. 4</td>
<td>80-90</td>
</tr>
<tr>
<td></td>
<td>No. 16</td>
<td>40-70</td>
</tr>
<tr>
<td></td>
<td>No. 50</td>
<td>10-30</td>
</tr>
<tr>
<td></td>
<td>No. 100</td>
<td>0-10</td>
</tr>
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</table>

The aggregate shall be stored in a suitably graded area to ensure satisfactory draining of the stock pipe.

3.5 Reinforcing Steel

The reinforcement shall consist of a woven or welded wire mesh. Woven wire mesh shall be of the hexagonal type with extra longitudinal wires. Size of hexagonal mesh openings shall be 1.5 inches across the minimum dimensions. Welded wire mesh shall have openings of 1-inch by 2-inch.

The wire mesh shall be galvanized and the materials shall conform to ASTM A82, A90, A185 and A641 as applicable.

The minimum wire diameter shall be 14 gage.

4.0 EQUIPMENT AND LABOR

The CONTRACTOR shall provide equipment and personnel capable of applying concrete coating to the specified degree of uniformity with respect to unit weight and strength. The CONTRACTOR’s equipment shall provide for either the batching of
material by weight or continuous mixing, where all feeds are accurately controlled and percentages of mix are calibrated by weight. Batching scales shall be maintained in good condition. Any equipment that tends to separate the ingredients shall not be used.

5.0 CONCRETE COATING MIX

5.1 Mix Design

The CONTRACTOR shall design the mixes using the approved aggregates and shall determine the proportions which will give the required concrete density and strength. All mix designs shall be agreed with the COMPANY before commencement of coating. All concrete mixes shall be designed to minimize drying shrinkage.

Full details shall be provided by the CONTRACTOR with regard to:

a. The proportions and weights of the respective materials used in the mix.
b. The water/cement ratio.
c. The gradings of the various aggregates with combined curves as necessary.
d. Laboratory test results for compressive strength and unit weight of concrete.

5.2 Compressive Strength Requirements

The minimum compressive strength as determined from tests outlined in Section 7.3.1 shall not be less than 3,500 psi after 7 days and 4,650 psi after 28 days.

5.3 Weight Requirements

The nominal weight-per-foot of coated pipe shall be as specified in the CONTRACT. The weight-per-foot of a coated pipe joint shall not deviate in excess of plus 7 percent or minus 5 percent from the specified weight-per-foot in air. Compliance shall be checked by the tests outlined in Section 7.3.4.

In addition, the average weight-per-foot in air of 5 successively coated joints shall be greater than or equal to the required weight-per-foot in air.

5.4 Water Absorption

The water absorption after 48 hours, as determined from tests outlined in Section 7.3.2 is not to exceed four percent of the dry concrete weight in air.

5.5 Density

The density of the concrete shall have a nominal value of 190 pcf. The tolerance of the density shall be plus or minus 5 percent as determined from the tests outlined in Section 7.3.2.

5.6 Thickness

The concrete coating shall be of uniform thickness around the circumference and along the length of the pipe. Around the circumference, the thickness shall not vary more than ¼ inch between the highest and lowest points at any given cross-section. Along the length, the thickness shall not vary more than ¼ inch between successive high and low points.

The overall average thickness (as determined by averaging girth measurements at 5 equally spaced locations along the length) shall not vary more than ±¼ inch from the nominal specified thickness.

5.7 Concrete Cut-back End Taper

The concrete coating shall be cut-back from the ends of the pipe joints and no concrete shall be applied for a distance of 12 inches from the ends. At the ends, the concrete coating shall be tapered at a 60° slope with respect to the longitudinal axis of the pipe. The base of the taper shall be no closer than 12 inches and no further than 14 inches from the root face of the beveled ends.

6.0 CONCRETE COATING PROCEDURES

6.1 Concrete Application
The concrete weight coating shall be applied by either the high impact velocity method or by the compression method. The concrete shall be applied on joints of pipe that have been previously coated with coal-tar enamel as per COMPANY Specification 2136600-SP-018.

No concrete shall be applied when the surrounding temperature at the curing station is 40°F. At any phase of the coating, if the temperature can go below 40°F the CONTRACTOR shall submit his procedure for weight coating below 40°F. If during the coating period the temperature goes below 40°F, the coating shall be protected according to the approved procedure.

All mixed concrete which is not placed within 45 minutes after the initial introduction of water into the mixture shall be rejected and shall not be used to coat the pipe.

Each joint of pipe shall be coated in a continuous operation. Where practical, the total thickness of coating shall be applied in a single pass. No more than 30 minutes shall be allowed between passes in any case.

The uncoated portion of the pipe ends and the bevels shall be kept clean and free from concrete spatter, oil, grease, etc.

If kraft paper has been placed on the joint to protect the corrosion coating, the paper shall be completely removed before the joint is concrete coated.

6.2 Reinforcing and Forming

The reinforcing steel shall be applied in such a manner as to provide continuity of reinforcement. All circumferential and longitudinal reinforcing splices shall overlap no less than 6 inches.

For concrete thicknesses less than or equal to 2½ inches, one layer of reinforcement shall be placed midway between the outer and inner surfaces of the concrete. A minimum ½ inch of cover shall be maintained between the reinforcement and the outside of the concrete. For concrete thicknesses greater than 2½ inches, two layers of reinforcement shall be used. Reinforcement layers shall be placed equidistant from the pipe, the outer surface of the concrete and each other. A minimum 3/4-inch of cover shall be maintained between the outer layer of the reinforcement and the outside of the concrete.

The reinforcing steel shall not be in electrical contact with the pipe. At the beginning of coating for each pipe diameter/concrete thickness combination, a joint randomly selected by the COMPANY shall be checked with electric power source and meter. This check shall be repeated at random approximately every 100 joints. Any concrete removed to make the test shall be repaired.

Reinforcing wire shall not be exposed at the ends of the concrete coating.

6.3 Anode Joints

Anodes shall be installed on the pipe in accordance with COMPANY Specification 2136600-SP-016. For anode joints, care shall be taken to ensure that there is no contact between the anode and the reinforcing wire. A minimum 2-inch separation shall be maintained between the anode and reinforcing wire. Concrete weight coating shall be applied up to each side of the anode and tapered to the outer diameter of the anode. Following installation of the weight coating, the outer surface of the anode shall be brushed cleaned for any concrete or other materials, and the anode/reinforcing wire shall be meter tested to assure isolation of the anode. Anode joints shall be cured and stored separately from other weight coated joints.

6.4 Curing

Following concrete coating application, the coated pipe shall be carefully handled and moved to a curing area. In the curing area, the pipe shall be placed in a single layer and supported in a manner that does not damage the concrete or allow the concrete to cure with the pipe in a deflected shape.
The coated joints shall not be transported from the curing area to storage until they have cured satisfactorily for 4 days. No coated pipe shall be shipped from the coating yard until it has cured for at least 10 days.

Either water or membrane curing may be used, but whichever is used, the concrete shall not be allowed to dehydrate.

6.4.1 Water Curing

Water curing shall come later than 2 hours after coating. The concrete weight coating shall be kept continuously moist by means of intermittent watering for a period not less than 4 days, and kept surface-wet during daylight hours for seven days. Either manual or mechanical watering may be used.

6.4.2 Membrane Curing

Membrane curing compound shall be of the white pigmented type conforming to ASTM C309. It shall be applied by mechanical apparatus to the coated surface in sufficient quantity to provide complete coverage in accordance with manufacturer’s recommendations. The application of this curing compound shall take place immediately after coating is completed and preferably before the pipe is removed from the concrete coating apparatus.

The surface of the concrete shall be lightly sprayed with water before applying the curing compound. The membrane shall be continuous over the concrete and shall remain so for a minimum of 7 days.

7.0 INSPECTION AND TESTING

7.1 General

The COMPANY shall have full and free access to the office, plant, every part of the coating yard, and the on/off loading facilities of the CONTRACTOR. CONTRACTOR shall assist the COMPANY or his representative at every stage.

7.2 Causes for Rejection

Pipe coating not meeting the requirements of this specification shall be rejected and recoated by the CONTRACTOR without expense to the COMPANY. Coating shall be rejected for the reasons as follows:

a. Mechanical/Strength

i. Improper placement of reinforcing steel or reinforcement which is in electrical contact with the line pipe or anodes.
ii. Concrete compressive strengths below the specified values.
iii. Damage to handling or storing considered by the COMPANY to be excessive and beyond repair.
iv. Improper curing procedures.

b. Weight/Dimensional

i. Weight in air outside the specified tolerances.
ii. Coating thickness outside the specified range.
iii. Concrete density outside the specified range.
iv. Coating which has abrupt irregularities and variations in thickness around the circumference and along the length outside the specified range.
v. Water absorption greater than specified value.
vi. Coating cut-back outside the specified range or which is not properly tapered.

7.3 Testing Methods

Daily samples of the concrete mix, as applied during the coating operation, shall be taken to determine the compressive strength and unit weight of the concrete coating. In addition, each joint of pipe shall be weighed and the coating thickness measured.

All testing shall be at the CONTRACTOR’s expense and as directed by the COMPANY or his representative. The testing methods to be used are outlined below.
7.3.1 Compressive Strength Test

Compressive strength of the mix shall be determined from samples prepared at the job site. Tests shall be carried out in accordance with ASTM C39. A minimum of two test cylinders (prepared in accordance with ASTM C31) shall be taken in the morning, and two in the afternoon for each day of production. These cylinders shall be tested to determine the 7 day and 28 day compressive strength of the concrete.

7.3.2 Concrete Unit Weight and Water Absorption Tests

The density of the concrete shall be determined from hardened and cured concrete that is not less than the 4 days of age, and is taken from the coating mix as applied in normal coating operations. One cylinder type model shall be taken for each morning and one for each afternoon of production to be used for these tests. Water absorption tests for the concrete shall be carried out in accordance with the following requirements and ASTM C642.

A sample shall be oven dried at 210°F to constant weight. When constant weight is attained, a sample shall be allowed to cool to room temperature and be weighed to the nearest gram. The sample shall be submerged in seawater at room temperature for not less than 48 hours. While submerged in seawater, it shall be weighed to the nearest gram. It shall then be withdrawn from the water, the excess of surface moisture removed, and the sample weighed again to the nearest gram. The weight per cu. ft. and water absorption shall be calculated as follows:

Weight per cu. ft. = Oven Dry Wt. x 64
Saturated Wt. - Suspended Immersion Wt.

% Water Absorption = Saturated Wt. - Oven Dry Wt. 100
Oven Dry Weight

The coating thickness shall be checked at the ends of the coating to determine if the line pipe is concentrically placed inside the weight coating jacket. The variation in coating thickness around the circumference shall not exceed the limits defined in Section 5.6 of this specification.

The diameter (and average coating thickness) shall be determined at five locations along the length of each pipe joint by taking girth measurements. The locations for the girth measurements shall be equally spaced and shall include at least 80% of the coated length. The variation in average coating thickness shall not exceed the limits defined in Section 5.6 of this specification.

In addition, the surface of the concrete coating shall be spot checked to determine that surface irregularities do not exceed the limits defined in Section 5.6.

7.3.4 Coated Pipe Weight Tests

The coated pipe weight-per-foot in air shall be computed using the following formula:

\[ w_{air} = \frac{[W_m - W_{steel} (L_p - L_c)]}{L_c} \]

where

- \( w_{air} \) = calculated weight-per-foot in air (lb./ft.)
- \( W_m \) = measured weight-in-air of the fully cured weight coated joint of pipe, (lb.)
- \( W_{steel} \) = the weight-in-air per unit length of uncoated steel pipe.
- \( L_c \) = API-5L nominal weight per unit length is acceptable, (lb./ft.)
- \( L_p \) = the measured length (bevel to bevel) of the pipe joint, (ft.)

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\[ L_c = \text{the measured length (center-of-taper to center-of-taper) of the concrete coating, (ft.)} \]

8.0 REPAIRS AND ACCEPTANCE

8.1 Repair of Pipe

CONTRACTOR shall inspect any pipe furnished by others upon receipt. All flaws discovered in pipe not furnished by the CONTRACTOR and not caused by the CONTRACTOR will be repaired as approved by the COMPANY. At COMPANY’s discretion, these joints shall be set aside, with no cost to the CONTRACTOR. The CONTRACTOR shall provide storage space for and shall handle all pipe repairs.

All damage to the pipe bevels or facing, which exceeds API-5L allowances for bevel or face damage, such as dents, gouges and flattening, shall be cut out and the pipe rebevelled and refaced or, at the COMPANY’s discretion, shall be set aside.

8.2 Coating Repairs

After concrete coatings have hardened, damage during handling and storage shall be repaired as described below.

8.2.1 Spalling

Spalling caused by impact with other objects, shall be repaired as follows:

i. 

Damaged area of less than 1 sq. ft., where depth of damaged does not expose the reinforcing wire, and where the surrounding concrete is sound, shall be acceptable without repairs.

ii. 

Damaged area exceeding any of the criteria of i., up to a total damaged area of 3 sq. ft., shall be undercut to provide a key lock for repairs.

iii. 

Damaged area exceeding 3 sq. ft. shall have the concrete coating removed around the entire pipe circumference and for a sufficient length to include the entire damaged portion.

Repairs shall be made by satisfactorily restoring the reinforcement (if necessary); removing all cracked or broken concrete at the point of coating damage; wetting the fresh surface of the broken coating; and troweling a stiff mixture of cement water and aggregate (of the same materials and proportions as the coating) into and through the reinforcement. This mixture shall be built up until the surface is level with the coating around the repair. The pipe shall then be carefully laid in a position where it shall be allowed to moist cure for a minimum of 7 days.

No pipes shall be accepted if spalling extends to the enamel layer.

8.2.2 Cracking Due to Pipe Deflection

Cracks that are in excess of 1/16-inch in width and extend over 180° circumferentially around the pipe, or longitudinal cracks over 12-inch in length (irrespective of width), shall be repaired. Repair shall be made by chiseling the crack out to a width of not less than 1-inch throughout the length of the crack. The crack shall be repaired with materials similar to that form which the coating is made. The repairs shall be kept moist and be allowed to remain undisturbed for a period of not less 48 hours.

9.0 IDENTIFICATION AND MARKING

9.1 Paint Stenciling

The CONTRACTOR shall paint stencil the inside of each joint of pipe with the information as follows:

a. Concrete coating thickness and density
b. Measured weight-in-air (empty pipe)

9.2 Color Coding

For a given pipe diameter, the CONTRACTOR shall propose a color coding system which uniquely identified each concrete thickness.

Each joint of coated pipe shall then be color coded accordingly with a 3-inch wide band painted around the circumference at each end of the joint.
In addition, a second band shall be painted to identify anode joints.

9.3 Records

In addition to the above, the CONTRACTOR shall maintain daily logs and promptly provide COMPANY with a permanent certified record for each joint of pipe which shows the information as follows:

a. Serial number
b. Pipe mill and mill number
c. Pipe diameter, wall thickness and grade
d. Measured pipe joint weight prior to and after concrete application
e. Measured pipe joint weight after curing
f. Measured average diameter of concrete coating
g. Date of coating

10.0 STORAGE, HANDLING AND SHIPPING

Pipe shall be handled and stored in a manner to prevent damage to pipe walls, beveled ends, and coating. Pipe shall be handled, transported and stored in accordance with COMPANY Specification No. 2136600-SP-017. All pipe handling shall be with equipment approved by the COMPANY’s representative. Pipe or coating damaged by the CONTRACTOR in handling or other operations shall be satisfactorily repaired at no expense to the COMPANY.

The coated pipe shall be stacked in such a manner that the exterior coating does not contact a hard surface which will cause coating damage. Stacking height shall be reduced at COMPANY representative's request if he observes detrimental effects to the pipe or coating due to stacking.

Pipe will be transported from the coating yard to the jobsite by truck, rail or barge, as specified in the CONTRACT. Pipe shall be shipped in such a manner as to adequately protect the pipe and its coating. Pipe shall be loaded for shipping in compliance with existing shipping standards and regulations.

11.0 PERFORMANCE OF WORK

CONTRACTOR shall guarantee that work performed on external coating of pipe shall be in accordance with this specification and that the application of the coating system shall be in accordance with the specifications of the coating material manufacturer. The COMPANY’s representative shall have proper access rights to CONTRACTOR's plant and property to assure the COMPANY that the foregoing specifications are being followed.