

**VALLECITOS WATER DISTRICT
SECTION 09801 – MANHOLE PROTECTIVE LINING**

PART 1 – GENERAL.

1.1 DESCRIPTION

- A. The Contractor shall coordinate District provided manhole protective linings complete in place, in accordance with this Section. This protective lining shall be used for all interior surfaces of the manhole or vaults that require the application of a protective lining. The protective lining shall be Zebron lining system. Substitutions will not be allowed.
- B. Definitions
 - 1. The term “paint”, “coatings”, “linings”, or “finishes” as used herein, shall include all surface treatments, emulsions, enamels, paints, epoxy resins, and all other protective linings, excepting galvanizing or anodizing, whether used as a pretreatment, primer, intermediate coat, or finish coat.
 - 2. The term “DFT” means minimum dry film thickness.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. All related work specified elsewhere, or in other codes or standards, will be as last revised, unless a specific date of issuance is called out in opposition to later revision date(s).
- B. Other sections of the Standard Specifications, not referenced below, shall also apply to the extent required for proper performance of this Work.
 - 1. Section 01300 – Submittals
 - 2. Section 03461 – Precast Reinforced Concrete Manholes
 - 3. Section 03462 – Precast Concrete Vaults

1.3 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. Except as otherwise indicated, the current editions of the following apply to the Work of this Section:
 - 1. References herein to “SSPC Specifications” or “SSPC” shall mean the published standards of SSPC, the Society for Protective Coatings.
 - 2. References herein to “NACE” shall mean the published standards of the National Association of Corrosion Engineers.
 - 3. NACE
 - a. Publication 6D-173, “A Manual for Painter Safety”
 - b. Publication TPC2, Coatings and Linings for Immersion Service; Chapter 1 Safety, Chapter 2 Surface Preparation, Chapter 3 Curing, and Chapter 4 Inspection

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- c. RP0892 Standard Recommended Practice, Lining over Concrete in Immersion Service.
 - d. RP0188 Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates.
 - e. RP0288 Standard Recommended Practice, Inspection of Lining on Steel and Concrete.
4. ASTM
- a. B499 Standard Test Method for Measurement of Coating Thickness by the Magnetic Method: Nonmagnetic Coatings on Magnetic Basis Metals
 - b. C109 Compressive Strength Hydraulic Cement Mortars
 - c. C579 Compressive Strength of Chemically Setting Silicate and Silica Chemical Resistant Mortars
 - d. C794 L.R. Standard Test Method for Adhesion-in-Peel of Elastometric Joint Sealants (Modified for field conditions)
 - e. D543 Resistance of Plastics to Chemical Reagents
 - f. D638 Tensile Properties of Plastics
 - g. D695 Compressive Properties of Rigid Plastic
 - h. D790 Flexural Properties of Unreinforced and Reinforced Plastics
 - i. D2240 Durometer Hardness Type D
 - j. D2369 Standard Test Method for Volatile Content of Coatings
 - k. D2584 Volatile Matter Content
 - l. D4138 Standard Test Methods for Measurement Dry Film Thickness of Protective Coating Systems by Destructive Means
 - m. D4262 Standard Test Method of pH of Chemically cleaned or Acid Etched Concrete Surfaces
 - n. D4414 Standard Practice for Measurement – Wet Film Thickness by Notched Gages

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- o. D4541 Standard Method for Pull-Off Strength of Coatings using Portable Adhesion Testers
 - p. D4787 Standard Practice for Continuity Verification of Liquid or Sheet Linings Applied to Concrete Substrates
 - q. D5162 Standard Practice for Discontinuity Testing of Nonconductive Protective Coating on Metallic Substrates
 - r. E337 Standard Practice Test Method for Measuring Humidity with a Psychrometer
5. International Concrete Repair Institute (ICRI)
- a. No. 03732 Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays
 - b. No. 03733 Guide for Selecting and Specifying Materials for Repair of Concrete Surfaces
6. Federal Specifications
- a. OSHA 1910.144 – Safety Color Code for Marking Physical Hazards
7. American Concrete Institute (ACI)
- a. ACI506.2.77 – Specifications for Materials, Proportioning, and Application Concrete Institute (ACI)
8. SSPWC 210-2.3.3 – Chemical resistance testing published in the Standard Specifications for Public Works Construction (“Greenbook”), most recent edition.

1.4 SUBMITTALS

- A. Submittals shall be furnished in accordance with the Standard Specifications unless indicated otherwise below.
- B. Submittals shall include the following information:
 - 1. Protective Lining Materials List: Three copies and an electronic copy of the protective lining materials list showing the manufacturer and the protective lining number. The list shall be submitted before or at the time of submittal of samples
 - 2. Manufacturer’s Information: The Contractor shall provide the following data:
 - a. Technical data sheet for each product proposed, including ASTM test results indicating the product conforms to and is suitable for its intended use per the Contract Documents. Data shall include curing requirements and duration.

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- b. Detailed sequence of work for protective lining work.
 - c. Shop Drawings: Show locations and extent of coating. Including details for substrate joints and cracks, penetrations, inside and outside corners, tie-ins with adjoining coatings, if any, and other termination conditions.
 - d. Technical and performance information that demonstrates compliance with the system performance and material requirements.
 - e. Protective lining manufacturer’s instructions and recommendations on surface preparation and application.
 - f. Certification of compatibility from all product manufacturers of protective linings, concrete rehabilitation products, grouts, sealants, or other materials used in the manhole rehabilitation process.
 - g. Safety Data Sheet for each product used.
 - h. Material and Installation Warranty as specified below.
 - i. Statement from manufacturer that they have reviewed the Standard Specifications and that they certify that their product, as specified herein, is recommended and appropriate for this application.
 - j. Applicator Qualifications:
 - i. Manufacturer certification that Applicator has been trained and approved in the handling, mixing, and application of the products to be used.
 - ii. Certification by the protective lining manufacturer that the equipment to be used for applying the products has been approved and Applicator personnel have been trained and certified for proper use of the equipment.
 - iii. Experience and references of projects for Contractor and Lining Applicator.
 - iv. Proof of any necessary federal, state, or local permits or licensed applicator.
3. Inspection records of shop or field-applied protective linings and linings for buried or submerged items shall be submitted within 15 days after the Work has been accepted.

1.5 SPECIAL CORRECTION OF DEFECTS REQUIREMENTS

- A. Warranty Inspection

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1. The warranty period for the coating material specified herein shall be for a one (1)-year period and shall include a 1-year product warranty from protective lining manufacturer and 1-year installation guarantee by the Contractor and Lining Applicator. The Contractor shall be responsible for the repair of any defects in the protective lining which may develop during the warranty period. Defects shall be repaired to the satisfaction of the District at the Contractor's expense and without cost to the District. The defects must be corrected within a two-month period.

1.6 SERVICES OF MANUFACTURER

- A. The Contractor shall require the Protective Lining Manufacturer to furnish the following services:
 1. Manufacturer shall provide certification that the Contractor's Lining Applicator is either a licensed applicator for the specified product or has been trained and qualified by the manufacturer to apply their product.
 2. The manufacturer shall have directly employed, full-time, on-staff chemists that interface directly with the in-house manufacturing personnel. The Chemist(s) interfacing with the production personnel shall be available to the District and the Contractor for technical support during the construction phase and warranty period. The manufacturer shall, if directed by the District, provide on-site technical support on a reasonable fee basis.
 3. All coating product(s) manufactured and marketed by the same company Certification (no toll blending).

1.7 QUALITY ASSURANCE

- A. The Protective Lining Applicator shall initiate and enforce quality control procedures consistent with applicable ASTM, NACE, and SSPC standards and the manufacturer's recommendations.
- B. The Protective Lining Applicator shall conform to all local, State, and Federal regulations including those set forth by OSHA, RCRA, and the EPA and any other applicable authorities.
- C. The District Engineer or their designee shall observe daily operations, procedures, and final product to evaluate conformance with the specifications and recommendations of the Protective Lining Manufacturer.
- D. For further inspection and testing details, see Section 3.4.
- E. The Contractor shall furnish inspection devices in good working condition through final acceptance of linings to demonstrate that protective linings are installed in accordance with these specifications and the manufacturer's written instructions. The following inspection equipment (or District approved equal) shall be used, as necessary and as directed by the District, for performing quality control testing in accordance with the Standard Specifications:

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1. High range wet and dry film thickness.
2. High voltage holiday detector (capability to 16,000 Volts)
3. Portable Adhesion tester.
4. Additional inspection equipment may be required at the request of the District Engineer or their designee.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. All materials shall be stored, handled, and transported according to their safety data sheets and the manufacturer's written recommendations.

1.9 SAFETY AND HEALTH REGULATIONS

A. General

1. The Contractor shall perform all work in accordance with the requirements of OSHA Safety and Health Standards for Construction (29CFR1926) and the applicable requirements of regulatory agencies having jurisdiction, as well as manufacturer's printed instructions and appropriate technical bulletins and manuals. In accordance with these standards, the Contractor shall provide and require use of personal protective lifesaving equipment for persons working in or about the project site. Safety and health recommendations provided herein are guidelines only. The Contractor shall be fully responsible for performing all Work in accordance with all local, State, and Federal regulations including those set forth by OSHA, RCRA, and the EPA and any other applicable authorities. Protective coating materials are to be handled according to their safety data sheets.

B. Head and Face Protection and Respiratory Devices

1. Equipment provided by the Contractor shall include protective helmets which shall be worn by all persons while in the vicinity of the Work. Workers engaged in or near the Work during any blasting or application operations shall wear OSHA approved eye and face protection devices and air purifying, half-mask or mouthpiece respirators. Barrier creams shall be used on any exposed areas of skin.

C. Ventilation

1. Where ventilation is used to control hazardous exposure, all equipment shall be explosion-proof. Forced air ventilation shall be provided by the Contractor and shall reduce the concentration of air contaminant to a safe limit. Air circulation and exhausting of solvent vapors shall be continued until coatings have fully cured.

D. Sound Levels

1. Whenever the occupational noise exposure exceeds maximum allowable sound levels, the Contractor shall implement, furnish and require the use of approved ear protective devices.

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E. Temporary Ladders and Scaffolding

1. All temporary ladders and scaffolding shall be provided by the Contractor and shall conform to applicable safety requirements. They shall be erected where requested by the District to facilitate inspection and shall be moved by the Contractor to locations as requested by the District.

PART 2 – PRODUCTS

2.1 PROTECTIVE LINING

- A. Prior to application of the polyurethane topcoat, all surfaces shall receive a 1 – 3 mil thickness of a 100% solids non-solvented, moisture-tolerant, low temperature cure, epoxy primer as is manufactured by Zebron Corporation, California.

Zebron Corporation
P. O. Box 2874
Newport Beach, CA 92659

Tel: 1-800-824-4214; Fax: 1-714-632-6647

The primer materials shall be 100% solids, moisture tolerant epoxy capable of spray application to 1-3 mils thickness in one continuous coat.

The lining material shall be a plural-component, 3 - 1 mix ratio, 100% solid, non-solvented hybrid polyurethane coating with a shore “D” hardness of 57 at 77 degrees Fahrenheit such as Zebron #386 as manufactured by Zebron Corporation, California. The material shall be the high-build type capable of application thickness, as specified, without runs or sags and shall be capable of passing ASTM D-1737 for flexibility using cylinder mandrel of 0.5 inch (12.7 millimeter). The flash point of the fluid mixture shall be 450 degrees Fahrenheit.

The coating material shall meet the following resistive specifications:

Solution - Concentration

Acetic Acid - 5%
Sulfuric Acid - 20%
Sodium Hydroxide - 5%
Ammonium Hydroxide - 5%
Nitric Acid - 1%
Ferric Acid - 1%
Soap - 0.1%
Detergent (Linear Alkyl Benzyl Sulfonate or LAS) - 0.1%
Bacteriological - BOD not less than 700 PPM
Petroleum Oils and Greases - N/A
Vegetable and Animal Oils - N/A
Volumetric percentages of concentrated C.P. grade reagents

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The material shall have evidence of passing the “Pickle Jar Test” as is noted in section 207-15.3 Chemical Resistance, in the “Greenbook” Standard Specifications for Public Works Construction, 2006 Edition. The material shall also meet the requirements specified in 500-2.4, and the table 500-2.4.10(A), in the “Greenbook” Standard Specifications for Public Works Construction, 2006 edition. The color shall be white or cream. The complete coating shall be impermeable to sewer gases and liquids and nonconductive to bacterial or fungus growth. The lining shall be capable of repair at any time during its life.

PART 3 – EXECUTION

3.1 GENERAL

- A. The sewer system shall remain operable during rehabilitation and protective lining work in accordance with the responsibilities and requirements of the Standard Specifications.

3.2 SURFACE PREPARATION

- A. All surfaces receiving the protective lining shall be made free of oils, grease, water, incompatible existing coatings, waxes, form release, curing compounds, efflorescence, sealers, salts and other contaminants that may inhibit bonding to the substrate or lining performance. High pressure water blasting (minimum 5,000 psi) shall be used for surface preparation. Other methods such as high pressure water jetting (refer to NACE Standard No. 5/SSPC SP-12), abrasive blasting, detergent water cleaning, hot water blasting, shot blasting, grinding, or scarifying may also be used, but only if the protective lining manufacturer certifies in writing that the surface preparation procedure is acceptable and recommended for use with their product. All sand, generated waste, and/or debris resulting from surface preparation must be immediately removed and legally disposed of by the Contractor. After surface preparation operations, the concrete surfaces shall be tested to verify that the pH is between 6 and 9 prior to applying the coating, or additional cleaning or conditioning shall be performed to achieve the specified pH.
- B. The Contractor shall capture and remove debris and extraneous materials during the manhole rehabilitation and coating work and to prevent any debris or materials from entering the sewage system.
- C. If abrasive blasting is selected as the surface preparation technique, the Contractor shall contain abrasives to prevent intrusion into the atmosphere, traveled way, or into the existing sewer system.
- D. All concrete or mortar that is damaged by chemical exposure or is otherwise considered unsuitable, in the opinion of the District Engineer or their designee, to receive bonding agents, patching material, or new lining material shall be removed to expose durable, intact concrete.
- E. The Contractor shall remove any existing coatings prior to application of the new protective coating. Applicator is to maintain strict adherence to applicable NACE and SSPC recommendations with regard to proper surface preparation.

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- F. The manufacturers of all materials used for manhole rehabilitation, including the protective lining manufacturer, shall provide written certification stating that their products are mutually compatible.
- G. The Contractor shall stop infiltration and/or leaks prior to applying protective linings.

3.3 APPLICATION OF PROTECTIVE COATING

- A. Application procedures shall conform to the recommendations of the protective lining manufacturer including material handling; mixing; curing requirements; environmental controls during application and curing; safety and application equipment.
- B. The polyurethane lining application shall take place after the gunite/mortar has cured for a minimum of 1 hour at 55 degrees Fahrenheit.
- C. The polyurethane application, the vault surfaces shall be primed with the epoxy primer to a thickness of 1 – 3 mils. The polyurethane lining is installed immediately after the epoxy primer application or up to 24 hours after the epoxy primer application. The polyurethane lining shall be applied to a minimum 125 mil thickness.
- D. Protective coating must be applied by a Certified Applicator of the protective primer and coating manufacturer and according to manufacturer specifications.
- E. Installation of the protective coating shall not commence until the concrete substrate has been properly cleaned, prepared, and cured.
- F. The temperature of the surface to be coated should be maintained between 40 degrees F and 120 degrees F during application. Prior to and during application, care should be taken to avoid exposure of direct sunlight or other intense heat source to the structure being coated. Where varying surface temperatures do exist, apply the coating when the temperature is falling versus rising (i.e. late afternoon into evening vs. morning into afternoon).
- G. Application of the lining shall not take place when exposed to rain, fog or high winds. It is the Contractor's responsibility to ensure protection of the work for the above-mentioned conditions.
- H. The minimum DFT shall be 125 mil thickness. If the Contractor chooses to install the coating thicker than this minimum DFT, it will be done at the Contractor's sole expense, with no additional compensation provided by the District, and only within recommendations and instructions from the coating manufacturer.
- I. During the application, the Contractor shall take we gauge film thickness readings as required to ensure correct lining thickness. The polyurethane lining shall be uniform in color, fully cured, and free of pinholes, surface imperfections, and blisters. All areas in question shall be removed and reworked and patched.
- J. The Contractor shall notch the concrete directly below the manhole frame to a depth and width of 1/4-inch with a grinding wheel. The coating shall be applied to the manhole wall and into the notch in one continuous sheet in order to provide a continuous coating from manhole frame to manhole wall. The coating shall extend down to cover the manhole shelf

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in its entirety and to overlap joints in the inlet/outlet sewer pipe penetrations. The coating shall not extend into the channel and flowline.

- K. The spray equipment shall be specifically designed to accurately ratio and apply the specified protective coating materials and shall be maintained in proper working order. The protective coating material must be spray applied by a Certified Applicator of the protective coating manufacturer.
- L. Subsequent top coating or additional coats of the protective lining shall be within the allowable time frame as required by manufacturer.

3.4 INSPECTION

- A. The District Engineer or their designee shall observe daily operations, procedures, and final product to ensure adherence to the specifications and recommendations of the Protective Lining Manufacturer. The District Engineer or their designee will observe completed surface preparation before coating. The District Engineer or their designee will observe spark testing and pull testing. A visual inspection will be performed upon completion. Any deficiencies in the finished coating shall be marked and repaired in strict accordance with the manufacturer's recommendations. Inspection and repair shall continue until final acceptance of linings at no additional cost to the District.
- B. During application, a wet film thickness gage, such as those available through Paul N. Gardner Company, Inc. meeting ASTM D4414 – Standard Practice for Measurement of Wet Film Thickness of Organic Coatings by Notched Gages, shall be used to ensure a monolithic coating and uniform thickness during application.
- C. After the protective coating has set too hard to the touch, it shall be inspected with high-voltage holiday detection equipment. Surfaces shall first be dried. An induced holiday shall then be made on to the coated concrete surface and shall serve to determine the minimum/maximum voltage to be used to test the coating for holidays at that particular area. The spark tester shall be initially set at 100 volts per 1 mil (25 microns) of film thickness applied but may be adjusted as necessary to detect the induced holiday (refer to NACE RPO188-99). The cured polyurethane lining shall be spark tested for pinholes with a spark tester set at 15,000 volts minimum. All pinholes shall be repaired as specified. All detected holidays shall be marked and repaired in strict accordance with manufacturer's recommendations.
- D. Bond strength of the protective coating to the substrate shall be measured in accordance with ATSM D4541. Any areas detected to have inadequate bond strength shall be evaluated by the District. Further bond tests may be required by the District Engineer or their designee on structures that have inadequate bond strength to determine the extent of potentially deficient bonded area. A minimum of three (3) 3/4-inch dollies shall be affixed to the lined surface at the cone area, mid-section and at the bottom of the structure selected for testing by the District Engineer or their designee. A minimum of 10% of the lined manholes shall be tested as determined by the District Engineer or their designee. The adhesive used to attach the dollies to the liner shall be rapid setting with tensile strengths in excess of the liner material and permitted to cure in accordance with the manufacturer recommendations. The lining material and dollies shall be adequately prepared to receive the adhesive. The coating shall be scored around the dolly through to the substrate. Failure

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of the dolly adhesive shall require re-testing. Two of the three adhesion pulls shall exceed 200 psi or concrete failure with more than 50% of the subsurface adhered to the coating. If one of the three dollies fails, an additional location shall be tested in the same structure. If two of the four dollies tested fail, the un-adhered coating shall be removed and replaced at the Contractor's expense. If a structure fails the adhesion test, one additional structure or 10% of the initial number of structures selected for testing, whichever is greater, shall be tested at the discretion of the District. Additional tests and repairs shall be made by the Applicator and in strict accordance with the manufacturer's recommendations at no additional cost to the District. Applicator shall repair any coating damaged during bond strength testing at no additional cost to the District.

3.5 REPAIR METHODS

- A. All defects in the gunite/mortar shall be repaired as specified in 303-2 in the "Greenbook" Standard Specifications for Public Works Construction 2006 Edition. All pinholes in the protective lining shall be highlighted with black indelible ink for the purpose of identifying them for the repair process. Using the pinholes as a center point, the area 6 inches around the pinhole must be abraded with a 60-grit paper or "equivalent". Abraded surfaces are then cleaned, primed and top coated Zebron #385 hand mix. Blisters, uncured lining, and surface imperfections shall be completely removed and the areas recoated with epoxy primer and polyurethane lining to a point 6-inches beyond the repair areas at minimum thickness of 100 mils. Where imperfections exceed an area of one square-foot, the Contractor shall repair as stated above using the Zebron #386 spray applied polyurethane.

****END OF SECTION****