

**DIVISION 9 – FINISHES**  
**SECTION 09 97 23 – CONCRETE AND MASONRY COATINGS**

**PART 1 – GENERAL**

1.01 SECTION INCLUDES:

- A. This specification covers the work necessary to furnish and install a complete corrosion resistant lining system for new or existing force main discharge manholes. The corrosion resistant lining shall be spray applied, monolithic, and cover the entire interior of the manholes. Work includes, but is not limited to, the following:
  - 1. Cleaning the manholes of sedimentation and debris.
  - 2. The removal of any loose and unsound material.
  - 3. Performing surface preparation for the lining application.
  - 4. Applying patching products and the lining product.

1.02 RELATED SECTIONS

- A. Section 01 33 00 – Submittal Procedures.
- B. Section 33 05 13 – Manholes and Precast Structures.

1.03 REFERENCES

- A. ASTM C579 – Compressive Strength of Chemically Setting Silicate and Silica Chemical Resistant Mortars.
- B. ASTM D543 – Resistance of Plastics to Chemical Reagents.
- C. ASTM C580 – Flexural Strength and Modulus of Elasticity of Chemical Resistant Mortars, Grouts, Monolithic Surfacing, and Polymer Concretes.
- D. ASTM C905 – Standard Test Methods for Apparent Density of Chemical Resistant Mortars, Grouts, Monolithic Surfacing, and Polymer Concretes.
- E. ASTM D638 – Tensile Properties of Plastics.
- F. ASTM D695 – Compressive Properties of Rigid Plastics.
- G. ASTM D790 – Flexural Properties of Unreinforced and Reinforced Plastics.
- H. ASTM D2584 – Volatile Matter Content.
- I. ASTM D2990 – Test Methods for Tensile, Compressive and Flexural Creep and Creep Rupture in Plastics.

- J. ASTM D4414 – 95(2007) Standard Practice for Measurement of Wet Film Thickness by Notch Gages.
- K. ASTM D4541 – Pull-off Strength of Coatings Using a Portable Adhesion Tester.
- L. NACE – Published standards of the National Association of Corrosion Engineers.
- M. SSPC – Published standards of the Society of Protective Coatings.
- N. SSPC SP-13/NACE No. 6 – Surface Preparation of Concrete.

1.04 QUALIFICATION

- A. Manufacturer and Contractor specializing in the performance of work specified in this section with a minimum of three (3) years documented experience.
  - 1. Submit references of at least five (5) projects performed within the past three years. These projects must be similar in scope and complexity to the project being bid. These references shall include the following:
    - a. Project title, locations, and contract value.
    - b. Project description, including structure size.
    - c. Client contact, including customer name, address, and contact.

1.05 QUALITY ASSURANCE

- A. Furnish materials of quality required by ASTM standards or other approved standards and specifications.
- B. Coating products shall be capable of being installed and curing properly within the specified environments. Coating products shall be resistant to all forms of chemical or bacteriological attack found in municipal sanitary sewer systems and capable of adhering to the substrates and repair products.
- C. Contractor shall utilize equipment for the spray application of the coating products which has been approved by the coating product manufacturer. Contractor shall have received training on the operation and maintenance of said equipment from the coating product manufacturer.
- D. Contractor shall be trained by, or have their training approved and certified by, the coating product manufacturer for the handling, mixing, application and inspection of the coating products to be used as specified herein.
- E. Contractor shall be trained in the use of testing or inspection instrumentation and knowledgeable of the proper use, preparation and installation of the coating products to be used as specified herein.

- F. Contractor shall initiate and enforce quality control procedures consistent with the coating products manufacturer recommendations and applicable NACE or SSPC standards.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Materials are to be kept dry, protected from weather and stored under cover.
- B. Protective coating materials are to be stored between 50 degrees F and 90 degrees F. Do not store near flame, heat or strong oxidants.
- C. Protective coating materials are to be handled according to their material safety data sheets.

1.08 WARRANTY

- A. Contractor shall warrant all work against defects in materials and workmanship for a period of 3 years, unless otherwise noted, from the date of final acceptance of the project. Contractor shall, within a reasonable time after receipt of written notice thereof, repair defects in materials or workmanship which may develop during said 3 year period, and any damage to other work caused by such defects or the repairing of same, at his own expense and without cost to the Owner in accordance with the General Conditions.

**PART 2 – PRODUCTS**

2.01 LINING SYSTEMS

- A. Manufacturers
  - 1. Carboline.
  - 2. Sprayroq, Inc.
  - 3. Raven Lining Systems, Inc.
  - 4. Sauereisen.
  - 5. Or equal.

2.02 SYSTEMS

- A. Reactamine ET as manufactured by Carboline.
  - 1. Epoxy Primer (Carboguard 1340 WB)
    - a. Two-component, water-borne epoxy primer to serve as a primer/sealer for concrete substrates. It promotes the adhesion of a variety of topcoats including polyurea elastomers.

2. Liner Material (Reactamine ET)
- a. 100% pure polyurea flexible coating and lining system designed to protect concrete surfaces against corrosion conforming to the following minimum physical requirements:

Tensile Strength	ASTM D412	>2,400 psi
Elongation	ASTM D412	>340%
Tear Strength	ASTM D624	>540 pli
Hardness	ASTM D2240	≥Shore D 45
Flexibility	ASTM D1737	Pass 1/8" Mandrel
Taber Abrasion (CS17 Wheel; 1000 gm weight; 1000 cycles)	ASTM D4060	≥25 mg loss

3. Comply with manufacturer's recommendations for installation procedures. Apply materials in accordance with the following material coverage:
- a. Primer: 1.5-2.0 mils.
- b. Coating/Lining: 80-125 mils (minimum).

A. SprayWall as manufactured by Sprayroq, Inc.

1. Liner Material.
- a. Polyurethane spray applied monolithic liner system conforming to the following minimum physical requirements:

Compressive Strength	ASTM D695	>7,500 psi
Tensile Strength	ASTM D638	>7,200 psi
Flexural Strength	ASTM D790	>12,000 psi
Bond		Shall exceed tensile strength of substrate.
Flexural Modulus, initial	ASTM D790	>700,000 psi
Flexural Modulus, long term	ASTM D2290	500,000 psi
Density		+/- 87 pcf
Tensile Modulus	ASTM D638	>400,000 psi
Chemical Resistance	ASTM D534	Municipal sanitary sewer environment

2. Patching, Profiling, and Grouting mix shall be as required and recommended by the lining system manufacturer for suitability. It shall be mixed and applied according to the manufacturer's recommendations.

B. Raven 405 as manufactured by Raven Lining Systems, Inc.

1. Liner Material.

- a. 100% solids, solvent-free ultra high-build epoxy spray applied monolithic liner system conforming to the following minimum physical requirements:

Product Type		Amine cured epoxy
VOC Content	ASTM D2584	0%
Compressive Strength	ASTM D695	>18,000 psi
Tensile Strength	ASTM D638	>7,500 psi
Flexural Modulus	ASTM D790	>600,000 psi
Adhesion to Concrete	ASTM D4541	Substrate (concrete) failure
Chemical Resistance	ASTM D534	Municipal sanitary sewer environment

2. Patching, Profiling, and Grouting mix shall be as required and recommended by the lining system manufacturer for suitability. It shall be mixed and applied according to the manufacturer's recommendations.

C. SewerGard No. 210 lining system as manufactured by Sauereisen.

1. Epoxy Liner (SewerGard No.210S).

- a. A 100% solids, fiber-filled, spray-applied material designed to protect concrete surfaces of municipal wastewater treatment structures conforming to the following minimum requirements:

Compressive Strength (ASTM C-579)	6,800 psi
Tensile Strength (ASTM C-307)	2,500 psi
Flexural Strength (ASTM C-580)	4,600 psi
Bond	Shall exceed tensile strength of substrate.
Density (ASTM C-905)	77 pcf
Tensile Modulus	42,000 psi
Chemical Resistance	Municipal sanitary sewer environment

2. Topcoat (SewerGard Glaze No. 210G).

- a. A 100% solids epoxy polymer to serve as a protective sealing topcoat over the Epoxy Liner. Topcoat shall be resistant to corrosive conditions, moisture tolerant, and suitable for use in a municipal sanitary sewer environment. Topcoat shall be applied to all rehabilitated surfaces to provide protective seal.

3. Patching, Profiling, and Grouting mix shall be as required and recommended by the lining system manufacturer for suitability. It shall be mixed and applied according to the manufacturer's recommendations.

**PART 3 – EXECUTION**

**3.01 SURFACE PREPARATION**

**A. Concrete**

1. The NACE/SSPC Joint Surface Preparation Standards for concrete surface preparation are incorporated in and made part of this specification. All references to SSPC SP-13/NACE No 6 designate the definitions and other requirements in these documents.
2. Place covers over all pipe openings to prevent extraneous material from entering the sewer system. All foreign material shall be removed from the structures' wall and bench/floor using pressure water spray (minimum 3000 psi). Remove all loose or protruding brick, mortar and concrete.

**3.02 SAFETY**

- A. The Contractor shall carry out this operation in strict accordance with all OSHA and manufacturer's safety requirements.
- B. Appropriate actions shall be taken by Contractor to comply with local, state and federal regulatory and other applicable agencies with regard to environment, health and safety during work.

**3.03 PRE-INSTALLATION**

- A. Inspection of the new wet well structures and manholes and existing manholes shall be performed by experienced and trained personnel. The interior of the wet well structures and manholes shall be carefully inspected for any condition which may prevent proper installation of the lining, and it shall be noted so that the condition may be corrected.
  1. Sanitary sewer flow control: The Contractor shall provide for bypass of the flow or sewage flow around the structure(s) designated for lining as necessary.
  2. Pre-Installation Cleaning:
    - a. Place screens over all pipe openings to prevent extraneous material from entering the piping.
    - b. Remove any existing coatings prior to application of the coating products which may affect the performance and adhesion of the coating products.
    - c. Thoroughly clean existing concrete structures to receive lining to effect a seal with the coating products.
    - d. Oils, grease, incompatible existing coatings, waxes, form release, curing compounds, efflorescence, sealers, salts, or other contaminants which

may affect the performance and adhesion of the coating to the substrate shall be removed.

- e. Concrete and/or mortar damaged by corrosion, chemical attack or other means of degradation shall be removed to sound substrate and repaired.
- f. When any reinforcing bar is uncovered, continue removal of concrete to provide a minimum of 1" clear depth all around the bar. Wire brush the exposed reinforcement steel surfaces to remove rust and laitance, and apply an approved epoxy paint.
- g. Surface preparation method(s) should be based upon the condition of the structure and concrete or masonry surface, potential contaminants present, access to perform work, and required cleanliness and profile of the prepared surface to receive the coating product(s).
- h. Surface preparation method, or combination of methods, that may be used include high pressure water cleaning, water jetting, abrasive blasting, shotblasting, grinding, scarifying, detergent water cleaning, hot water blasting and others as referenced in NACE No. 6/SSPC SP-13. Whichever methods are used, they shall be performed in a manner that provides a uniform, sound clean neutralized surface suitable for the specified coating products.

3. Pre-Installation Appurtenances Protection: The Contractor shall protect all installed appurtenances, including but not limited to, access ladder and supports, sewage grinder, manhole steps, access hatches and manhole frame and covers.

4. Flat Wall Structure Preparation: Angled grooves shall be cut in the walls of the flat wall structures on both vertical and horizontal centers to create a mechanical lock of the liner with the concrete structure and to create "beams". The beam centers shall range from one (1) to five (5) foot centers to create the desired beam design. The configuration of the cut groove shall be 1/8" wide x 1/4" deep and shall be angled 30 degrees. The angle shall be alternated to properly align the locking mechanism.

B. Contractor shall be responsible for temporary sealing all piping connections to the structures during the lining process to prevent the accumulation of water, and debris into the structure.

#### 3.04 APPLICATION OF PATCHING AND PROFILING, INFILTRATION, AND GROUTING PRODUCTS

A. Patching, grouting and profiling products shall be used to fill voids, bugholes, and other surface defects which may affect the performance or adhesion of the coating products. Patching and profiling products shall be used to repair, smooth or rebuild surfaces with rough profiles to provide a concrete or masonry substrate suitable for the coating products to be applied. These products shall be installed to minimum thickness as recommended within manufacturers published guidelines.

- B. Infiltration mix products shall be used to stop minor water infiltration.
- C. Grouting mix products shall be used to stop active water infiltration.
- D. Patching and profiling and grouting mix products shall be handled, mixed, installed and cured in accordance with manufacturer guidelines.
- E. All repaired or resurfaced surfaces shall be inspected for cleanliness and suitability to receive the coating products. Additional surface preparation may be required prior to coating application.

3.05 APPLICATION OF LINING PRODUCTS

- A. Application procedures shall conform to the recommendations of the System manufacturer, including environmental controls, product handling, mixing, application equipment and methods.
- B. Application Temperature: No application of liner shall be made unless the outside temperature is 50 deg F or higher.
- C. Spray equipment shall be specifically designed to accurately ratio and apply the coating products and shall be in proper working order.
- D. Contractors qualified in accordance with Section 1.05 of these specifications shall perform all aspects of coating products installation.
- E. Prepared surfaces shall be coated by spray application of the coating products described herein to a minimum wet film thickness of 150 mils. Prepared surfaces to be coated to provide a monolithic liner include but are not limited to:
  - 1. Manhole:
    - a. Walls.
    - b. Bench.
    - c. Flow Channels.
- F. Subsequent topcoating or additional coats of the coating products shall occur within the product's recoat window. Additional surface preparation procedures will be required if this recoat window is exceeded.
- G. Coating products shall interface with adjoining construction materials throughout the structures to effectively seal and protect concrete or masonry substrates from infiltration and attack by corrosive elements. Procedures and materials necessary to effect this interface shall be as recommended by the coating products manufacturer.
- H. Termination points of the coating products shall be made at the manhole frame and cover joint, a minimum of 1" interfacing with each wet well access hatch, and a minimum of 1" interfacing with each pipe penetration shall be provided.



- I. The finished surfaces shall be smooth, free of ridges, wrinkles, and sags. Special care shall be used to insure a smooth transition between the wet well/manhole invert and intersecting pipeline inverts such that flow will not be impaired. Should any of these conditions occur, the liner shall be repaired according to the manufacturer's standards or liner shall be rejected and removed at Contractor's expense.
- J. Sewage flow shall be stopped, bypassed or diverted for application of the coating products to the invert and interface with pipe materials.

### 3.03 TESTING AND INSPECTION

- A. During application a wet film thickness gauge, meeting ASTM D4414 - Standard Practice for Measurement of Wet Film Thickness of Organic Coatings by Notched Gages, shall be used. Measurements shall be taken, documented and attested to by Contractor for submission to Engineer.
- B. Visual inspection shall be made by the Engineer. Any deficiencies in the finished coating shall be marked and repaired according to the procedures set forth herein by Contractor.
- C. Contractor shall be responsible for providing the services of an independent, third party laboratory to perform testing in accordance with ASTM D790 to certify that the flexural modulus of the lining system meets the requirements specified in this Section. The definition of Long term value will be identified as initial flexural modulus less the reduction in value caused by Creep over a fifty (50) year minimum period and verified by DMA testing. A minimum of one (1) sample per structure shall be tested.
- D. Contractor shall perform Pull Tests as described below to verify adhesion of the sprayed liner to the structure walls.
  - 1. Test Procedure:
    - a. Using a grinder with a flap wheel on it, abrade the surface slightly.
    - b. Using a 1" diameter hole saw without the center pilot drill installed, drill through the coating down to the substrate.
    - c. Glue an aluminum button to the coating section drilled in above. Glue it with epoxy and allow it to cure for 15 minutes. Longer times may be needed in colder temperatures.
    - d. Place a metal donut washer over the button, place dynamometer over same and hook to button, and gradually apply load until failure occurs, The final reading on dynamometer is value in pounds per square inch (psi). Record the psi value and location of the failure as either at the epoxy to button bond, in the substrate material below or in the liner material.
    - e. A satisfactory test will be considered as achieving a total load of 200 psi minimum.

2. A minimum of two (2) Pull Tests shall be performed in the top third of every wall section of the wet wells.

**END OF SECTION**