



**SPECIAL PROVISIONS
FOR
CORROSION PROTECTIVE LINING**

**Woodbury County
IM-NHS-029-7(49)149--03-97**

**Effective Date
December 15, 2015**

THE STANDARD SPECIFICATIONS, SERIES 2015, ARE AMENDED BY THE FOLLOWING MODIFICATIONS AND ADDITIONS. THESE ARE SPECIAL PROVISIONS AND THEY SHALL PREVAIL OVER THOSE PUBLISHED IN THE STANDARD SPECIFICATIONS.

150041.01 DESCRIPTION.

A. Summary.

1. Provide a chemically resistant epoxy lining system for modified manhole structures.
2. Provide a flexible High-Density Polyethylene (HDPE) or PVC T-Lock sheet liner with locking extensions into each reinforced concrete manhole structure to effectively protect concrete surfaces from corrosion.
3. Liner shall be continuous and free from any holes (including pinholes), defects or other faults both across joints and the liner itself. All jointing welding and sealing shall be equally as effective as the liner.
4. Liner shall be continuous from walls to ceilings around pipes and castings.

B. References.

1. **American Society for Testing and Materials (ASTM).**
 - a. ASTM D16 Type V.
 - b. ASTM D4437.
2. **International Concrete Repair Institute (ICRI).**

150041.02 MATERIALS.

A. HDPE/PVC Liner

1. General.

- a. The liners specified in this Special Provision shall be furnished by a manufacturer who is fully experienced, reputable and qualified in the manufacturing of the materials and who has in their employ a full-time field service representative with at least 5 years field experience. The liners shall be designed, constructed and installed using techniques recommended by the manufacturer.
- b. The manufacturer of the lining shall attest to the successful use of its product as a lining for sewage conditions or other chemical environments recognized as corrosive or otherwise detrimental to concrete.

2. Manufacturers.

- a. GSE Lining Technologies, Inc: GSE Studliner.
- b. AGRU America; Sure Grip.
- c. Ameron T-Lock.

3. Materials and Dimensions.

- a. The material used in the embedment liner and in all welding strips shall be a made from 97-98% virgin high density polyethylene and 2-3% carbon black or pigmentation for the purpose of an otherwise specified color. Plasticizers shall not be added to the resin formulation. The material color shall be yellow, white, or off-white. Dark colors will not be acceptable.
- b. Embedment sheets for field installation shall be produced in rolls that are a minimum of 6.5 feet in width with 78 mil thickness.
- c. Locking studs of the same material as that of the liner shall be integrally extruded with the sheet and have a minimum height of 0.40 inches. The maximum of 39 studs per square foot shall be installed on the liner. The maximum distance between studs shall be 2.127 inches.

4. Properties.

- a. All plastic embedment sheets and welding strips shall have the following physical properties when tested in accordance with the following table.

<u>Property</u>	<u>Test Method</u>	<u>Performance</u>
Thickness (Min)	ASTM D751	+/- 10%
Density g/cm3 (Min)	DIN 53479 / ASTM D792	0.94
Tensile Properties	DIN 53455 / ASTM D638	
Tensile Strength at Yield, lb/in2 (Min)		2200
Tensile Elongation at Break, % (Min)		600
Tensile Strength at Break, lb/in2 (min)		3600
Carbon Black Content % (Max)	ASTM D1603	2-3
Dimensional Stability, %	DIN 53515	+/- 2%
Linear Coefficient, in/in/°C	ASTM D696	1.2x10-4
Service Temperature		-70°F to 176°F
Stud Pull Out Strength (Min)		>4,300 psf

- b. Embedment sheets and welding strips shall be free of cracks, cleavages, or other defects adversely affecting the protective characteristics of the material. The Engineer may reject any materials which may be defective.
- c. Liner shall have demonstrated good chemical resistance via testing in accordance with EPA 9090.
- d. Weld strips shall have good impact resistance, be flexible, and have an elongation sufficient to bridge up to 0.5 inch settling cracks, which may occur in the structures or in the joint after installation, without damage to the strip. The lining shall be repairable at any time after installation in pipe, manholes or structures by methods approved and recommended by the manufacturer.

- e. Embedment sheets, either roll good or prefabricated panels, shall be supplied. Shop welds shall be made by a butt weld and fusing the sheets together by a thermal process such as an extrusion weld, fusion weld, or equal so as to produce continuous welded seams. Specimens taken from shop welded seams shall show no cracks or separations and shall be tested in tension. Each specimen shall withstand minimum shear strength of 60% of parent tensile yield strength.
- f. During installation of the embedment sheet onto the forms, there shall be no cuts made within the liner for purposes such as strapping of sheet. If straps are utilized they shall be placed so that the straps are positioned between embedment studs. Sheets may be supplied in prefabricated, pipe sized tubular shaped sheets, ready to install onto the inner form, or roll goods having specified dimensions listed in the Materials and Dimensions section.
- g. Joint strips for pipe seaming shall be approximately 4 inches wide with a minimum width of 3.75 inches. Thickness of joint strips shall be 118 mil.

B. Spray Liner for Modified Manhole Structures.

1. General.

- a. Where not otherwise shown, the extent of the spray applied epoxy polymer protective coating shall be applied to all interior surfaces of the modified (not round) sanitary sewer utility access.
- b. Spray applicants shall be designed and installed using technique recommended by the manufacturer, including all recommended materials.
- c. The manufacturer of the spray protective coatings shall attest to the successful use of its product as a lining for concrete, steel, and other surfaces for the wet well sewage conditions recognized as corrosive or otherwise detrimental to the surface.

2. Manufacturers.

- Induron Coatings, Inc.
- Mainstay
- Raven
- Sauereisen

3. Properties.

- a. Epoxy Lining Protective Coating shall meet the following:

<u>Property</u>	<u>Test Method</u>	<u>Performance</u>
Compressive Strength	ASTM C579	6800 psi
Tensile Strength	ASTM D638	2500 psi
Flexural Strength	ASTM C580	4600 psi
Bond Strength	ASTM D4541	Concrete Failure

- b. Volume of solids: 100%.
- c. Minimum applied thickness (dry film): 60 mils

4. Colors.

Colors shall be as selected by the Engineer.

5. Thinning, Mixing and Tinting.

- a. Where thinning is necessary, only the products of the manufacturer furnishing the coating will be allowed. All thinning shall be done in strict accordance with the coating manufacturer's recommendations.
- b. Mix in accordance to the manufacturer's recommendations.
- c. Each coat shall be slightly different in shade than the preceding coat, unless otherwise noted.

D. Delivery, Storage, and Handling.

1. Material shall be delivered to the site in original containers with labels intact and seals unbroken. Labels should provide the following information: material name, coating manufacturer, color name and number, batch or lot number, date of manufacture, mixing and thinning instructions.
2. All coatings shall be stored in an enclosed structure to protect them from weather and excessive heat or cold. Flammable coatings must be stored to conform to City, County, State and Federal safety codes for flammable coatings or paint materials. Store at minimum ambient temperature of 55°F and a maximum of 90°F and as required by manufacturer's instructions.
3. All empty containers shall be disposed of in accordance with local, state and federal regulations.
4. Coatings shall be within the indicated shelf life at their time of use.

150041.03 CONSTRUCTION.

A. Submittals.

1. Submit for review ahead of construction.
2. Product Data: Provide data indicating chemical and physical characteristics, performance criteria and substrate preparation.
3. Manufacturer's Installation Instructions: Indicate special procedures, surface preparation, welding, testing, perimeter conditions requiring special attention, corner details, special installation, and application equipment.
4. Submit to the Engineer for approval, shop drawings of installation details showing how the structures will be lined. The HDPE/PVC liner drawings shall show how returns, corners, joints, and coverage will be accomplished. No liner shall be placed until these drawings have been submitted to the Engineer and reviewed.

B. Quality Assurance.

1. HDPE/PVC Liner

- a. All HDPE/PVC liners shall be shop-tested for holes. Sheets having holes shall be satisfactorily repaired in the shop and retested prior to shipping the sheets to the project site or the pipe manufacturing plant. Repairs shall be made only by welders prequalified as provided herein.
- b. The Engineer may take test samples at the point of manufacture during production of sheet and strip material. All sheets and welds shall be tested in the field.
- c. Perform work in accordance with sealant manufacturer's requirements for preparation of surfaces and material installation instructions.
- d. Manufacturer: Company specializing in manufacturing the products specified in this Special Provision with minimum 5 years' documented experience.
- e. Applicator: Company specializing in performing the work in this Special Provision with minimum 3 years' experience.
- f. Maintain temperature and humidity recommended by the manufacturer during and after installation.

2. Epoxy Liner.

- a. **Certification Requirements.**

All coatings shall conform to OSHA requirements for allowable exposure to lead and other hazardous substances.

b. Product Manufacturer.

Manufacturer shall be a company that specializes in producing high quality industrial coating materials.

c. Applicator Qualifications.

- 1) Engage an experienced applicator with 5 years or more experience that has successfully completed coating system applications similar in material and extent to those indicated.
- 2) Applicator shall be able to supply suitable equipment to prepare the surfaces and applying the protective coating system specified within this Article.

d. Single Source Responsibility.

Provide coating material and thinners produced by the same manufacturer for each system on all surfaces of the manhole bench.

e. Field Painting Pre-Application Meeting.

Hold a pre-application meeting before the start of field surface preparation and coating application. Require attendance of parties directly affecting work of this Special Provision, including the engineer, applicator, inspector, and coating manufacturer's representative. Review the specifications to insure each party's responsibilities are understood. Subjects to be discussed are: environmental requirements, protection of surfaces not scheduled to be coated, surface preparation, application, repair, field quality control, cleaning, protection of coating systems, coordination with other work and any other areas of concern expressed at the meeting.

f. Dust and Contaminants.

Schedule coating work to avoid excessive dust and airborne contaminants. Protect work areas from excessive dust and airborne contaminants during coating application and curing.

C. HDPE/PVC Liner Installation.

1. The work shall include furnishing all labor, materials, equipment, and incidentals required to install manhole sheet liner with studded backside in concrete structures and appurtenances to effectively protect the exposed concrete surfaces from corrosion in those areas shown on the drawings or specified. The liner shall be continuous and free of pinholes at the joints and in the liner itself.
2. The installation of all plastic liner shall be done in accordance with these specifications. Liner shall be applied and secured to the forms and inspected and reviewed by the Engineer prior to the placement of reinforcing steel.
3. All work for and in connection with the installation of the lining, field seaming and welding of joints shall be done in strict conformity with all applicable instructions and recommendations of the liner manufacturer unless otherwise specified.
4. Installation of the lining and the welding of all joints shall be done in strict accordance with the manufacturer's instructions and recommendations and the details and methods indicated on approved shop drawings by an experienced and qualified installer acceptable to the manufacturer and the Engineer. Lining welders shall be trained and certified by the lining manufacturer prior to the start of welding. All pipe joints and other lined areas where welding is performed shall be numbered and initialed by the welder. Record on a daily basis at the end of each working day the identification of the joint areas and the welder who performed the work.
5. Coverage of the lining shall not be less than the minimum specified or as shown on the plans. Structures shall be fully lined on the interior, including man-way openings.

6. Concrete poured against lining shall be vibrated in a careful manner so as to protect the lining and produce a dense, homogeneous concrete, securely anchoring the locking studs into the concrete.
7. Forms shall be properly cleaned and prepared to remove any abrasive areas that may damage the liner when removing forms. In removing forms, care should be taken to protect the lining from damage. Sharp instruments shall not be used to pry forms from lined surfaces. When forms are removed, any nails that remain in the lining shall be pulled, without tearing the lining, and the resulting holes clearly marked. Form tie holds shall be marked before ties are broken off and all areas of abrasion or damage shall be marked.
8. Hot joint compounds, such as coal tar, shall not be poured or applied to the lining. Solvents or adhesives shall not be used in fusion of material in any manner.
9. Take all necessary measures to prevent damage to installed lining from equipment and materials used in or taken through the work area and shall immediately repair any damage.
10. All welding shall be performed in accordance with the published directives and procedures of the manufacturer and by welders certified by the manufacturer. Completion of welding shall provide a one piece monolithic concrete protective liner system that will provide excellent resistance to hydrogen sulfide attack and will not pull off the wall in the event that infiltration occurs.

11. Joints in Lining for Concrete Structures.

- a. Lining at joints shall be free of all mortar and other foreign material and shall be clean and dry before joints are made.
- b. Field joints in the lining shall be of the following types used as prescribed:
 - 1) Strip Type: The joint shall be made with a separate 4 inch wide joint strip and two welding strips. The 4 inch joint strip shall be centered over the joint, and then extrusion welded to the liner. The width of the space between adjacent sheets shall not exceed 1 inch. The 4 inch joint strip shall lap over each sheet a minimum of 1.5 inch. It may be used at any transverse or longitudinal joint.
 - 2) Lap Type: The joint shall be made by lapping sheets not less than 1 inch. The upstream sheet shall overlap the one downstream. The lap shall be tack-welded into place, then welded with an extrusion bead over the adjoined materials.
 - 3) Butt Type: Butt type welds will not be allowed for field welding of joints.
- c. All welding is to be in strict conformance with the instruction of the liner manufacturer. Welding shall fuse both sheets together to provide a continuous joint equal in corrosion resistance and permeability to the liner plate.

12. Testing.

- a. Field seaming involves bonding of adjacent panels using approved thermal methods such as extrusion welding. Testing and verification of the resulting welds will be required.
- b. Prior to any field welding of lined surface, trial seams shall be performed to ensure that the technician and method is adequate. Trial seams shall be performed on materials from the current project; a minimum of 3 feet in length. Trial weld seams shall then be tested to ensure equipment settings are sufficient to produce quality welds. Testing shall consist of non-destructive methods.
- c. Non-destructive testing shall consist of spark testing. Spark testing of the finished seams is required, a copper wire may be set into the weld joint prior to welding. This will allow for spark testing for the welded seam for determination of the presence of possible leaks in the weld. This process is not necessary but may provide an alternative method for non-destructive testing of the welds. Spark testing can be performed with approved instrumentation when set at approximately 20,000 to 35,000 volts depending upon apparatus. Any defects found should be marked and repaired according to approved repair methods. Repairs of pinholes and defective areas shall be performed by extruding

a bead of molten plastic over the surface, or if too large, a patch shall be utilized. Once complete, retest using the spark tester when applicable.

13. Field Seams.

- a. Non-destructive seam testing shall consist of spark testing. Spark testing allows for the welded seam to be tested for determination of the possible leaks in the weld. Spark testing may be performed over the entire surface of the weld and liner sheet. Spark testing shall be performed with approved instrumentation set at approximately 20,000 to 35,000 volts depending upon apparatus. Any defects found shall be marked and repaired according to approved repair methods. The spark testing device shall be equipped with an audible alarm indicated for signaling any defects.
- b. Repairs of pinholes and defective areas shall be performed by extruding a bead of molten plastic over the surface, or if too large, a patch shall be utilized. Once complete, retest using the spark tester when applicable.

D. Epoxy Liner Installation.

1. Examination.

- a. Examine areas and conditions under which the epoxy liner system is to be applied. Notify Contractor and Engineer of areas or conditions that are not acceptable. Do not begin surface preparation or application until unacceptable areas or conditions have been corrected.
- b. Protect surrounding areas and surfaces not scheduled to be coated from damage during surface preparation and application of epoxy liner system. Immediately remove epoxy liner system that fall on surrounding areas and surfaces not scheduled to be coated.
- c. All epoxy liner materials shall be mixed and applied at temperatures in accordance with these Specifications and the manufacturer's recommendation.
 - 1) Epoxy liner materials shall not be applied in inclement weather conditions.
 - 2) Ambient temperatures must be between 40°F and 85°F during application of epoxy liner materials. Relative humidity must be below 85%.
 - 3) The minimum substrate temperature at the time of application shall be 45°F. The maximum substrate temperature at the time of application shall be 100°F.
 - 4) At the time of application, the substrate temperature must be at least 5°F above the dew point.
 - 5) During application, the substrate temperature must be declining.
- d. Adequate lighting shall be provided to sufficiently light up all areas to be worked on without inclusion of shadow areas. Adequate lighting shall be considered a minimum of 20 foot candles in all areas in which work or inspection processes are occurring.
- e. Epoxy liner materials shall not be applied in windy conditions. Contractor shall ensure windblown matter is prevented from contaminating freshly coated surfaces.
- f. Keep containers closed when not in use to avoid contamination.
- g. Do not use mixed epoxy liner materials beyond pot life limits.
- h. Apply multiple coats within manufacturer's recommended recoat timeframe.
- i. Use application equipment, tools, pressure settings, and techniques in accordance with manufacturer's instructions.
- j. Uniformly apply epoxy liner materials at spreading rate required to achieve specified DFT.
- k. Apply epoxy liner materials to be free of film defects that would adversely affect performance of the liner system.

2. Repairs.

- a. Damaged Materials: Repair or replace damaged materials and surfaces not scheduled to be coated.
- b. Damaged Liner System: Repair damaged epoxy liner materials.
 - 1) Repairs shall be made with the epoxy liner system, surface preparation, and coat thickness specified in Article 120141.02, A of the Standard Specifications.

- 2) Complete replacement of the epoxy liner may be required by Engineer if the damaged or unsatisfactory area exceeds 2% of the total coated surface area.
 - 3) Prior to any repair work, the surface shall be cleaned in accordance with SSPC-SP 1.
 - 4) Intact areas around the damaged area shall be feathered by either hand sanding, power tool cleaning, or abrasive blast cleaning prior to the application of the epoxy liner.
- c. Liner System Defects: Completely replace the defective epoxy liner with the epoxy liner system, surface preparation, and coat thickness specified in Article 120141.02, A of the Standard Specifications.

150041.04 METHOD OF MEASUREMENT AND BASIS OF PAYMENT.

- A. Manhole/Utility Access Lining: Incidental to manhole and will not be paid for separately.
- B. Spray Liner for Modified Manhole Structures: Incidental to manhole and will not be paid for separately.