

## SECTION 09877

### HDPE EMBEDMENT LINER

#### PART 1--GENERAL

##### 1.01 DESCRIPTION

###### A. SCOPE:

This section specifies a high density polyethylene (HDPE) concrete protective liner with individual embedment studs for precast and cast-in-place members where shown on the Drawings.

###### B. APPLICATION:

Furnish all labor, materials, equipment and incidentals required to install HDPE liner with studded backside in precast and cast-in-place concrete to effectively protect the exposed concrete surfaces of structures from corrosion where shown on the Drawings. The liner shall be continuous and free of pinholes at the joints and in the liner itself.

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.

Where shown on the Drawings, the required faces of all precast concrete members shall be lined at the point of manufacture.

###### C. PERFORMANCE REQUIREMENTS:

Materials furnished under this section shall be suitable for exposure to wastewater containing some industrial wastes and digested solids. The wastewater may be expected to contain gross waste solids, vegetable parts, small sections of lumber, rocks, sand, silt, petroleum products, industrial solvents, and animal fats and oils. The wastewater will have a temperature of 50 degrees F to 130 degrees F and will have pH which may range from 6 to 8. All lining shall be impermeable to sewage gases, sewage liquids, sewage treatment chemicals and shall be nonconductive to bacterial or fungus growth.

All material, adhesives and incidentals necessary for proper application of HDPE lining shall be furnished by the same manufacturer and shall be compatible with each other and with the adhesives employed.

## 1.02 QUALITY ASSURANCE

### A. REFERENCES:

This section contains references to the documents listed below. They are a part of this section as specified and modified. Where a referenced document cites other standards, such standards are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, has been discontinued or has been replaced.

Reference	Title
ASTM D570	Water Absorption of Plastics
ASTM D696	Coefficient of Linear Thermal Expansion of Plastics Between - 30 Degrees and 30 Degrees with a Vitreous Silica Dilatometer
ASTM D746	Brittleness Temperature of Plastics and Elastomers by Impact
ASTM D751	Coated Fabrics
ASTM D1204	Linear Dimensional Changes of Nonrigid Thermoplastic Sheeting or Film at Elevated Temperature
ASTM D1505	Density of Plastics by the Density-Gradient Technique
ASTM D1603	Carbon Black in Olefin Plastics
ASTM D4437	Determining the Integrity of Field Seams Used in Joining Flexible Polymeric Sheet Geomembranes
ASTM D5199	Measuring the Nominal Thickness of Geosynthetics
ASTM D5397	Evaluation of Stress Crack Resistance of Polyolefin Geomembranes Using Notched Constant Tensile Load Test
ASTM D6693	Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene
EPA 9090	Compatibility Test for Wastes and Membrane Liners

## B. TESTING:

All lining shall be factory checked electrically to ensure freedom from porosity and imperfections. Lining material shall be factory tested per the standards listed above to meet the minimum product specifications specified in paragraph 09877-2.03.

### 1.03 SUBMITTALS

Submittals shall be provided in accordance with Section 01300 and shall include the following information:

1. A copy of this specification section, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. A check mark shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the CONTRACTOR, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph referenced to a detailed written explanation of the reasons for requesting the deviation. The CONSTRUCTION MANAGER shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the CONTRACTOR with the specifications. *Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.*
2. Complete HDPE liner layout information for each location where shown on the Drawings including details of liner at openings, joints, terminations and repairs. This plan shall be approved prior to starting work in this section.
3. Liner installation and field testing procedures to meet the requirements specified in paragraph 09877-3.03. Submit test results to CONSTRUCTION MANAGER as deferred submittal.
4. Include with shipment of liner, certified test reports that the liner and materials used were manufactured in accordance with standards specified herein.
5. Submit references from at least three projects of similar scope and complexity that the installer and the precast fabricator have successfully completed. Include contact name, telephone number, name of project, and a brief description of the work performed.

6. Submit one square foot of the liner, and one linear foot of a weld strip to the CONSTRUCTION MANAGER.

## 1.04 QUALIFICATIONS

The HDPE liner specified in this section 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 3 years of field experience. The HDPE liner shall be designed, constructed, and installed using techniques recommended by the manufacturer with approval from the CONSTRUCTION MANAGER.

The manufacturer of the lining shall attest to the successful use of its product as a lining for sewer pipes, manholes, digesters, or pump stations in sewage conditions or other chemical environments recognized as corrosive or otherwise detrimental to concrete.

Installation of the liner shall only be completed by an installer certified by the manufacturer.

## PART 2--PRODUCTS

### 2.01 MANUFACTURERS

The CITY and ENGINEER believe the following candidate manufacturer is capable of producing equipment and/or products that will satisfy the requirements of this section. This statement, however, shall not be construed as an endorsement of a particular manufacturer's products, nor shall it be construed that the named manufacturer's standard product will comply with the requirements of this section. Candidate manufacturers include GSE Studliner as manufactured by GSE Lining Technology, Inc., Huston, Texas, or equal. The CITY and ENGINEER are not aware of an equal manufacturer

### 2.02 MATERIALS AND DIMENSIONS

The material used in the embedment liner and in all welding strips shall be made from 97 to 98 percent virgin high-density polyethylene and 2 to 3 percent carbon black or pigmentation for the purpose of an otherwise specified color. Plasticizers shall not be added to the resin formulation.

Embedment sheets for field installation shall be produced in rolls that are 6.5 ft (2 m) in width, by 200 ft (61 m) in length with 120 mils (3 mm) thickness.

Locking studs of the same material as that of the liner shall be integrally extruded with the sheet to an approximate height of 0.40 inches (10 mm). Stud spacing shall be on approximate 1.25 inches (30 mm) centers, such that there are approximately 110 studs per square foot (1200 per square meter).

Joint strips, or welding strips, for seaming shall be approximately 4 inches wide and continuous along the length of the joint. Thickness of these strips shall be equivalent to that of the liner.

### 2.03 LINER PHYSICAL PROPERTIES

Embedment sheets, and welding strips shall be free of cracks, cleavages, or other defects adversely affecting the protective characteristics of the material. The CONSTRUCTION MANAGER may reject any materials which may be defective. All plastic embedment sheets, studs, and welding strips shall have the following physical properties when tested in accordance with test method specified below:

Nominal Properties for Embedment Liner

Property	Test method	Value
Thickness, mm (mil)	ASTM D751, D5199	3.0 (120) +/- 10 percent
Density, g/cm <sup>3</sup>	ASTM D1505	0.94
Tensile properties		
Tensile strength at yield, lb/in <sup>2</sup> (MPa)	ASTM D6693, Type IV, Dumbbell	2,200 (15.3)
Tensile elongation at break, percent	G.L. = 2.0 in (50 mm)	500
Notched constant tensile load, hrs	ASTM D5397	400
Carbon black content, percent	ASTM D1603	2-3
Dimensional stability, percent	ASTM D1204	+/- 1
Linear coefficient of thermal expansion, in/in/degrees C	ASTM D696	1.2x10 <sup>-4</sup>
Low temperature brittleness, degrees C	ASTM D746	-77
Service temperature, degrees F	--	-70 to 176
Water absorption, percent	ASTM D570	< 0.01
Stud pull out strength, psf	--	>14,000

Liner shall have demonstrated good chemical resistance via testing in accordance with EPA 9090.

Weld strips shall have good impact resistance, be flexible, and have an elongation sufficient to bridge up to 0.375 inch differential vertical movement without damage to the strip.

## 2.04 SUPPLY OF MATERIAL

For precast and cast-in-place containment structures, either roll goods or prefabricated pieces 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 percent of typical specified yield strength.

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 sheets, ready to install onto the inner form, or roll goods having specified dimensions listed in paragraph 09877-2.02.

## PART 3--EXECUTION

### 3.01 GENERAL

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 reviewed shop drawings by an experienced and qualified installer acceptable to the manufacturer and the CONSTRUCTION MANAGER. HDPE lining welders shall be trained and certified by the lining manufacturer prior to start of welding. All joints and other lined areas where welding is performed shall be numbered and initialed by the welder. The CONTRACTOR or precast manufacturer shall 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, and submit to CONSTRUCTION MANAGER in a timely manner.

Coverage of the lining shall not be less than the minimum specified or as shown on the Drawings.

When needed, the lining shall be held snugly in place against inner forms by means of steel banding straps or other means recommended by the manufacturer. Banding straps must be located in the interstitial space between studs to prevent crushing or tilting of the embedment studs. Minimal amount of banding straps to perform requirements shall be used and shall not interfere with concrete consolidation.

Where liner is extended for the purpose of joint overlap, embedment studs shall terminate not more than 1/2 inches from the end of the inside surface of the pipe section. Joint flaps shall extend approximately 4 inches beyond the end of the inside surface.

Concrete poured against lining shall be vibrated in careful manner so as to protect the lining and produce a dense, homogenous concrete, securely anchoring the locking studs into the concrete.

Forms shall be properly cleaned and prepared to remove any abrasive areas that may damage the liner. 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 holes shall be marked before ties are broken off and all areas of abrasion or damage shall be marked. Form ties and nails are not allowed except where specifically shown on the Drawings.

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.

The CONTRACTOR shall 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 per the manufacturer's recommendations.

### 3.02 JOINTS IN LINING

Lining at joints shall be free of all mortar and other foreign material and shall be clean and dry before joints are made.

Field joints in the lining shall be of the following types used where shown on the Drawings or described below:

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 inches. It may be used at any transverse or longitudinal joint.
2. Lap Type: The joint shall be made by lapping sheets not less than 2 inches. The lower sheet shall overlap the upper. The lap shall use double-sided tape flexible mastic initially placed on lower sheet and set onto upper sheet.
3. Butt Type: The joint shall be made by applying an extrusion bead to the back of the butt joint or by some other method acceptable to the CONSTRUCTION MANAGER to prevent concrete from getting under the sheet. After the forms have been stripped, a second extrusion weld bead shall be applied over the butt joint on the face of the sheet. The maximum gap shall be 0.25 inch for this method.

All welding is to be in strict conformance with the instruction of the liner manufacturer.

A manufacturer's representative shall be present during installation and field welding of plastic lining.

### 3.03 TESTING

Field seaming involves bonding of adjacent panels using approved thermal methods such as extrusion welding. The CONSTRUCTION MANAGER shall test trial seams by destructive and nondestructive methods prior to welding in the field or by the precast manufacturer. All field welds and welds on precast members shall be physically tested by nondestructive proving methods by the CONSTRUCTION MANAGER. The CONTRACTOR or precast manufacturer shall provide portable scaffolding for access for this testing and inspection. Testing and verification of the resulting welds are imperative to a quality installation.

Prior to any field welding of lined surface, trial seams of each type of joints shall be performed to ensure that the installer and method is adequate, at the precast manufacturer as well as on site. 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. Trial seam testing shall consist of both non-destructive and destructive methods in order to compare the results.

1. Non-destructive testing consists of vacuum box testing or spark testing, and pull testing. Spark testing is the preferred testing method; however, vacuum box testing may be used if accepted by the CONSTRUCTION MANAGER.
  - a. Vacuum box testing can be performed on all accessible welds according to procedures set forth by manufacturer; however this method is not regularly advised for cylindrical objects. Typically, a negative pressure of approximately 5 psig shall be applied to the seam. A defect in the weld will be noted by the presence of bubbles along the edge of the vacuum box. The defect shall be marked and repaired with approved methods by the manufacturer and retested.
  - b. Spark testing of the finished seams can be performed on all welds as applicable. A copper wire shall 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. Spark testing can be performed with approved electrical holiday or flow detector instrument set at approximately 20,000 to 35,000 volts, depending upon apparatus. Any defects found shall be marked and repaired with approved repair methods by the manufacturer and retested.
  - c. Pull testing shall be performed to each transverse welding strip which extends to a lower edge of the liner. The welding strips shall extend 2 inches below the liner to provide a tab. A 10-pound pull shall be applied to each tab. The force shall be applied normal to the face of the structure by means of a spring balance. The liner

adjoining the welding strips shall be held against the concrete during application of the force. The 10-pound pull shall be maintained if a weld failure develops, until no further separation occurs. Defective welds shall be retested after repairs have been made. Tabs shall be trimmed away neatly by the installer of the liner after the welding strip has passed inspection. Inspection shall be made within 2 days after joint has been completed in order to prevent tearing the projecting weld strip and consequent damage to the liner from equipment and materials used in or taken through the work.

2. When job requirements mandate destructive seam testing of trial seams, an appropriate number of samples should be agreed upon by all parties. Weld seams should then be tested for shear strength according to ASTM D4437. When proper welding techniques are followed, the weld shall withstand a minimum 60 percent of the typical specified tensile yield strength in shear.

Field seams shall be tested by the nondestructive testing described above. All repairs shall be made by the installer per the manufacturer's recommendations.

**\*\*END OF SECTION\*\***