SECTION 03130

plastic concrete liner

# GENERAL

## DESCRIPTION

### This section sets forth the requirements for all “Plastic Lining of Concrete” applied to concrete surfaces as shown on the drawings and as specified herein.

## RELATED WORK SPECIFIED ELSEWHERE

### The Work of the following Sections applies to the Work of this Section. Other Sections, not referenced below, shall also apply to the extent required for proper performance of this Work

#### Section 03310 - Cast in Place Sitework Concrete

#### Section 09800 - Painting and Coating

## general requirements

### Description of Protective Lining System: The Contractor shall provide materials, equipment and labor required to complete the work of applying a protective lining to the concrete surfaces indicated on the drawings. The protective bonded lining system shall be a semi-rigid PVC membrane that is fastened to the concrete surface with a structural polymer over the entire contact surface. The PVC membrane shall be set into the surface applied structural polymer while wet and cured to form a protective lining system for the concrete substrate.

### The Contractor shall submit to the Owner the following information prior to commencing the lining work:

#### Lining Manufacturer’s application and inspection guide;

#### Sequencing and layout plan for the lining system;

#### Material safety data sheets;

#### Applicators certification for each installer;

#### Proposed equipment for pre-cleaning the structure(s) of existing accumulated debris, and preparing the concrete surface of structure(s) prior to the installation of the new lining system, including rated operating pressures, flow rates in gallons per minute and total horsepower.

### Acceptance of Concrete Surface: Before starting the lining work, the Contractor applying the protective lining system shall thoroughly inspect all concrete surfaces to be lined. The lining Contractor shall notify the Engineer, in writing, of any defects or discrepancies, which will not allow him to complete his work properly. The Contractor shall repair defective surfaces as directed by the Engineer and as specified herein.

### Applicators Performance and Certification: The protective lining work of this section shall be performed with applicators who are trained and certified by the lining manufacturer. The successful bidder for the application of the protective lining system shall obtain a document of certification (to be submitted to the Engineer) issued by the Manufacturer of the protective lining system for each applicator that will be used in installing the lining system.

### Lining application done under this specification shall be inspected and documented by the Field Inspector, who has been trained and certified by the lining system manufacturer, and inspected by the Engineer. All parts of the work shall be accessible to the Field Inspector and the Engineer. Defective work shall be corrected as directed by the Engineer. Conformance of the work to the specifications shall be determined solely by the Engineer. Inspection by the Engineer and the Field Inspector by no means relieves the responsibility of the contractor to conform to the standards set by the specifications.

### Materials Information: All materials specified by name, brand or manufacturer shall be delivered unopened to the job in original containers with labels designating: name of the manufacturer, product name, batch number, quantity of contents and storage requirements. Stored materials in general shall be protected from excess heat, cold and weathering effects, as per manufacturer’s recommendations. Surface preparation and application of linings shall be performed in compliance with all applicable Federal, State and local occupational safety, health and air pollution control regulations. Safety precautions recommended by the lining manufacturer in printed instructions or special bulletins shall be obtained and followed.

### Sequence of Lining Operations: No work involving wet application of the protective lining system shall be performed concurrently with and adjacent to sandblasting and water blasting operations. Any contamination of surfaces by any means will require clean-up and reapplication to the satisfaction of the Engineer at no expense to the DISTRICT.

# MATERIALS

## GENERAL

### Materials shall consist of a primer, a PVC surface activator, a high solids structural polymer, a seam material, a UV top-coat, and extruded polyvinyl chloride (PVC) sheets and corner pieces as manufactured or supplied by Linabond, Inc., Sylmar, California, telephone number (818) 362-7373, or approved equal. Materials list for the protective lining system shall be submitted and shall include certification from a certified laboratory that the materials meet the following specifications..

## protective lining system materials

[Note to Engineer: Selected liner may vary from what is detailed below. Modify section 2.02 to match desired lining system]

### Primer: The concrete primer shall be a two (2) component, high solids primer with relatively fast cure, that provides a chemical and mechanical bond with the substrate and the structural polymer. Primer shall be Linabond EP30-HS Primer as manufactured by Linabond, Inc., Sylmar, CA, or approved equal.

### Structural Polymer: The structural polymer shall be a plural-component, high solids, high strength, closed-cell polyurethane. It shall be trowelable, or sprayable with airless-spray plural component equipment. It shall be non-flow and shall be resistant to weathering, aging, dilute (10%) solutions of sulfuric acid and intermittent wetting by raw sewage. The structural polymer shall be Linabond SP Mastic as manufactured by Linabond, Inc., Los Angeles, CA, or approved equal.

### Semi-Rigid PVC Sheet Liner: The material shall be a semi-rigid homogeneous thermoplastic polyvinyl sheet liner, that has been specifically formulated for application with the surface activator. The sheet liner shall be Linabond Semi-Rigid PVC Liner as manufactured by Linabond, Inc., Sylmar, CA, or approved equal.

### Flexible PVC Sheet Liner: The material shall be a homogeneous thermoplastic flexible PVC sheet liner of 40 mil uniform thickness, that has been specifically formulated for application with the surface activator. The sheet liner shall be Linabond Vinylthane Flexible PVC Liner as manufactured by Linabond, Inc., Sylmar, CA, or approved equal.

### Surface Activator: Surface activator shall provide cross-linking with the PVC sheet liner and the structural polymer and shall be Linabond CLA-2 Instant Activator as manufactured by Linabond, Inc., Sylmar, CA, or approved equal.

### Seam Material: This component is an expansionless version of Linabond’s structural polymer, which retains the chemical, and covalent bonding properties of the structural polymer. It is typically used for seam and termination overlay beads. It can also be in the overlaps between adjacent PVC sheets. Seam material shall be Linabond Mastic Seam Material as manufactured by Linabond, Inc., Sylmar, CA, or approved equal.

### Premolded PVC Corners: The Premolded corner units shall be made of Vinylthane that has been specifically formulated for application with the surface activator. All corners shall have minimum available lap area that is three (3) inches deep. The PVC premolded corners shall be as manufactured by Linabond, Inc., Sylmar, CA, or approved equal.

### PVC Lining U.V. Blocker: The PVC lining U.V. blocker shall be a one component, liquid-applied aliphatic polyurethane that is compatible with the PVC liner, and that has been especially formulated for weathering and ultraviolet light resistance. The U.V. blocker shall be Linabond No. 55 Aliphatic Top-Coat, as manufactured by Linabond, Inc., or approved equal.

# EXECUTION

## preparation of concrete surfaces

### General:

#### After pre-cleaning the structure and disposal of any accumulated debris, the Contractor shall repair all cracks and structural defects that may be the cause for providing a path for water to leak through the wall or joints. Following written approval from the construction manager, Engineer, Owner’s Representative or Inspector (Linabond, or other approved manufacturer, Certified) that all visual leaks have been stopped and properly repaired, the Contractor shall proceed with the required preparation of the exposed concrete wall surfaces prior to commencement of the liner installation.

#### The Contractor shall submit for review and approval by the construction manager, Engineer, Owner’s Representative or Inspector (Linabond, or other approved manufacturer, Certified)) the following: Equipment proposed for pre-cleaning the structure(s) of existing accumulated debris, and preparing the concrete surface of structure(s) prior to the installation of the new lining system, including rated operating pressures, flow rates in gallons per minute and total horsepower.

### Reference Standards:

#### This subsection references the latest revisions of the following documents. The requirements of this subsection take precedence over the listed references in the event of conflict.

##### ASTM D 4258 – Specification for surface cleaning concrete for coating

##### ASTM D 4259 – Specification for abrading concrete by hydro-demolition method

##### ASTM D 4262 – Standard test method for pH of chemically cleaned or etched concrete surfaces

### Equipment:

#### All equipment specified in this subsection shall be in good working condition and manufactured or fabricated to withstand the severity of the work covered under this subsection.

#### All equipment for hydraulic cleaning or hydroblasting shall include a water tank, auxiliary engine, pumps, and hydraulically driven hose reel. The Contractor shall take care not to damage the concrete structures with high-pressure water.

#### Hydroblasting equipment shall sustain water pressures of at least 20,000 psi at the nozzle with an output of at least 20 gallons per minute. Prior to use of the hydroblasting equipment, the Contractor shall demonstrate to the construction manager, Engineer, Owner’s Representative or Inspector (Linabond, or other approved manufacturer, Certified) that 20,000 psi minimum can be sustained at the above referenced volumetric output.

#### Sandblasting equipment shall be capable of supplying at least 375 cfm of air with a minimum pressure of 80 psig at the blast nozzle, as measured with a common nozzle pressure gauge. Abrasive blast nozzles shall have a minimum diameter of 0.5-inch and shall be of the venturi or other high velocity type. Air compressors shall be equipped with oil separators immediately downstream of the compressor discharge valves and at the discharge of the blast pot discharges. Prior to use of the sandblasting equipment, the Contractor shall demonstrate to the construction manager, Engineer, Owner’s Representative or Inspector (Linabond, or other approved manufacturer, Certified) that 80 psig minimum can be sustained at the above referenced volumetric output.

#### The Contractor shall provide ventilation for airborne particulate evacuations to meet all pertinent safety standards and to optimize visibility for both blast cleaning and inspection of the substrate during surface preparation work.

### Execution:

#### Prepare the concrete surface using one or a combination of the methods described in this Paragraph. Choice of method is left to the discretion of the Contractor, provided that the prepared surface meets the specified condition. In the event that the Contractor-selected method fails to produce the necessary surface preparation, additional methods or corrective action may be directed by the manufacturer and/or the Engineer.

#### **Wet abrasive blast:** Use clean, fresh water in combination with blasting material at sufficient pressures (minimum of 80 psig at the nozzle as measured with a common nozzle pressure gauge) to achieve the specified level of preparation. Blasting material should have a maximum particle size no larger than that passing through a No, 16-mesh screen, U.S. sieve series and should be arsenic-free. Abrasive blast shall remove all loose materials and open up surface defects. The surface, after a wet abrasive blast, shall be cleaned by rinsing with fresh water. This cleaning shall be supplemented by brushing, if necessary, to remove any residue. The surface should then be washed down to remove all dust particles.

#### **Hydro-blasting:** Use clean, fresh water at sufficient pressure and flow rate (of at least 20,000 psi at the nozzle with an output of at least 20 gallons per minute) to achieve specified level of preparation. Hydroblasting shall provide a clean, contaminate-free, roughened and sound surface. It is intended that the hydroblasting will slightly alter the surface profile of the concrete. It shall be assumed for bidding purposes that to reach a roughened and sound concrete surface, suitable to receive the specified lining systems.

#### **Dry sandblasting:** Use compressed air blast nozzles in combination with dry sand with sufficient pressures (minimum of 80 psig at the nozzle as measured with a common nozzle pressure gauge) to achieve the specified level of preparation. Blasting material should have a maximum particle size no larger than that passing through a No, 16-mesh screen, U.S. sieve series and should be arsenic-free. Abrasive blast shall remove all loose materials and open up surface defects. The surface, after dry sandblasting, shall be brushed with clean brushes made of hair, bristle, or fiber, blown off with compressed air (from which detrimental oil and water have been removed), or cleaned by vacuum, for the purpose of removing any traces of blast products from the surface, and also for the removal of abrasives from pockets and corners. The surface should then be washed down to remove all dust particles.

#### Acceptably cleaned and prepared surfaces shall be free of laitance, efflorescence, oil, grease, rust and other penetrating contaminants. The surface shall be free of loosely adhering concrete, dirt particles, thin crusts, and bridging voids. Surface preparation operations shall be performed under strict compliance with all Local, State and Federal safety requirements.

#### The protective lining system shall only be applied to clean sound concrete with adequate profile and porosity to provide a strong bond between the protective lining system and the substrate. The maximum surface profile amplitude allowed when a 3-yard straight edge is contacted on the surface in any direction shall be 1/2-inch maximum. Surface profiles deeper than 1/2-inch shall be repaired in accordance with Section XX using a patching compound compatible with the lining system.

#### Prior to application of the primer, the surface of the prepared concrete shall be dry. A dry surface is defined as a surface where there is no visible water darkening, beading, dripping or running on the substrate. Surface moisture shall be within the Green Range (0-85) on the Delmhorst Moisture Meter reference scale. Surfaces contaminated by debris shall be cleaned and dried before application of the lining system. The Contractor shall provide whatever methods and equipment necessary to achieve a dry surface condition. If compressed air equipment is utilized, it shall be equipped with oil filter and water separators with sufficient capacity to provide clean, dry air. Heated, forced air ventilation may be required to attain a minimum of 65 degrees F minimum temperature in the structure.

### Testing:

#### The Contractor in the presence of the construction manager, Engineer or Owner’s Representative shall perform all testing. The pH of the prepared surface shall be tested prior to installation of the liner system. The acceptable pH range for the prepared surface is 7 to 12. The Contractor in the presence of the Engineer or Owner’s Representative shall perform all testing.

## Protective lining system INSTALLATION

### **Field Inspector:** The Contractor shall be responsible for obtaining the services of a qualified field inspector who has been trained and certified by the manufacturer of the protective lining system. The Field Inspector shall continuously perform testing and provide daily field documentation and inspection services to the lining Contractor during all the protective lining installation to document as to whether the work, including surface preparation, mixing, drying times and application procedures, is being performed per the manufacturer's recommendations. The field inspector shall review performance, quality, and progress of the lining system work, and shall inform the Engineer and/or the Owner of its findings. The Field Inspector shall provide daily electronic documentation (including photography and QC forms), and monitor the progress and quality of the lining system work as per Manufacturer inspection requirements. A private internet workroom containing each day’s QC documents, testing and photographs will be made available by Manufacturer to the Owner and Engineer for the purpose of monitoring installation progress, quality, and compliance to the specifications.

### **Test Application:** Prior to beginning the lining work, the lining Contractor shall prepare a test area in a location designated by the Engineer and shall demonstrate the protective lining system application. This test area shall be a minimum of 10 square feet and will be used by the Engineer for approval of proper application procedures and quality of workmanship for the lining work.

### **Control of Ambient Conditions in Structures to be Lined:** The Contractor shall control ambient conditions in the structures to be lined, and provide protective enclosures during surface preparation, application, and curing to meet the ambient conditions specified below. The Contractor shall continue to meet the ambient conditions throughout the lining system work.

The ambient conditions requirements inside the structures during all phases of lining system work shall be as follows:

#### **Air temperature:** no lower than 65 degrees F. Lining at temperatures greater than 90 degrees F should be avoided as they drastically reduce the work-life of the structural polymer material.

#### **Relative humidity:** No higher than 90%.

#### Concrete substrate surface temperature: no lower than 55 degrees F but, and at least 5 degrees F higher than the dew point temperature. Lining at temperatures greater than 90 degrees F should be avoided as they drastically reduce the work-life of the structural polymer material.

#### No dust generation shall be allowed during this period.

### **Protective Lining Application:** The protective lining shall completely seal the areas shown on the drawings and as specified in Part 1 of this section. The system shall consist of four parts: primer, structural polymer, surface activator and polyvinyl chloride lining materials.

#### **Proportioning and Mixing:** The structural polymer, the primer, and the seam material shall be mixed and proportioned in accordance with the manufacturer’s written instructions using equipment acceptable to and certified by the manufacturer.

#### Once application begins, the Contractor shall have such equipment available, maintained, and kept in good working order for the duration of the work. The Owner’s designated representative shall daily verify that the equipment is set to the proper operating parameters. No verification or inspection releases the Contractor from responsibility for equipment availability, equipment operation, material application, or any other requirements of the specifications.

#### Spray equipment shall be able to provide plural component spray at a mix ratio of equal parts (one part to one part) by volume. For the structural polymer, spray equipment shall be capable of supplying a minimum of 3 gallons per minute at a temperature of 130-140 degrees F at the spray nozzle. Mix ratio, application flow rate, temperature and pressure readings must be verifiable through a monitoring system including digital readout and hard copy printouts. The readouts and printouts must show instantaneous and cumulative value readings for mix ratio and volumetric flow rate. For any 8 of 10 readings, mix ratio and flow rate must meet the values specified above within a plus or minus 5 percent maximum deviation. A solenoid shutdown device shall be provided to turn off the spray equipment in the event that the mix ratio exceeds said 5 percent maximum deviation. (Such equipment is available through dealers such as Spray-Quip, Inc., 713-923-2771, who are familiar with these materials.)

#### **Pumping and Computer and Miscellaneous Equipment:** Pumping equipment and computer equipment utilizing an integrated Digital Flow Monitoring system with built in alarms shall be approved by the Manufacturer prior to use. The Contractor shall supply all the tools and equipment needed to properly install the materials per Manufacturer’s requirements, including but not limited to the following: fiberglass crown jacks (if required), seam material plural component application guns, spray application rig, communications equipment and any necessary staging equipment. All equipment shall be maintained and operated per the manufacturer’s written instructions. Filters shall be checked twice daily (if operated) and cleaned as necessary. At all times during use, a qualified operator certified by the manufacturer shall attend the spray equipment.

#### **Primer:** The primer shall only be applied to a clean, prepared, and dry sound-concrete surface only. The primer shall be rolled or spray applied and allowed to tack prior to application of the structural polymer. The structural polymer should be applied within 3 days of primer application.

#### **Structural Polymer:** The structural polymer shall only be applied to a clean and dry primed concrete surface at a minimum average thickness of 125 wet mils or sufficient to completely embed the PVC liner material, whichever is greater. If the material is trowel applied, the material shall be mixed per the manufacturer’s recommendations, and shall be applied in the manner described in the Manufacturer’s application guide. If a notched trowel is used, rake marks will cause air entrapment in the liner, and therefore should be smoothed before embedding the PVC liner. If the material is spray applied, the spray equipment as described elsewhere in this document shall be utilized and maintained by the contractor. Bubbles in the liner greater than an equivalent area of 6-inch by 6-inch, and holes or discontinuities in the applied lining system, shall be repaired as specified in part 2.6 of this section. The Contractor shall keep accurate records of the placement of structural polymer and other system materials. Two copies of the records shall be submitted to the Engineer daily.

#### **Activator:** The surface activator shall be applied to clean, dry PVC liner material by roller at a coverage rate between 150 and 200 square feet per gallon, in accordance with manufacturer’s instructions. The Activator shall be applied to sheets in a warm (70 degree F minimum), protected environment. Under no circumstances should Activator, which has been allowed to sit open and evaporate, be applied. Activated polyvinyl chloride sheets shall be protected from debris or contamination prior to installation.

#### **Sheet Liner:** The activator prepared surface of the PVC sheet liner shall be pressed into the structural polymer in the manner shown in the application guide and rolled to remove trapped air. PVC sheets shall be applied while the structural polymer is still in its wet and uncured state as described in the manufacturer’s Application Guide. Temporary supports may be necessary on curved or otherwise stressed areas. When the surface temperatures of the structure walls or roof to be lined are rising due to exposure to exterior direct sunlight and/or will be completely encapsulated by lining, out-gassing of air or vapor from the concrete may result in bubbling, pinhole formations, and/or blistering in the lining system. Application of the lining system in such locations shall be postponed until the concrete is no longer exposed to direct sunlight, and its temperature is stable or dropping. The Contractor shall prevent such rising substrate temperatures by protecting the concrete substrate from sunlight or scheduling installation during advantageous times of day. Should bubbles, pinholes, or discontinuities form in the applied lining system, they shall be repaired as specified in part 2.6 of this section. Whenever possible, the Contractor shall use heat-forming of the semi-rigid PVC liner to conform to any odd shapes or details in the structure. Heat-forming of the liner shall be done before the structural polymer is applied. Where heat-forming is not possible, the Contractor shall use the flexible PVC liner.

#### Sheet Liner Seams, Terminations, and Leading Edges: The PVC lining system shall extend to the limits shown on the drawings. All liner seams shall be completed as described in the manufacturer’s Application Guide and detail drawings of this specification. The liner seams shall be of the overlap type (See Detail x for Overlap Joint). Overlap seams shall be lapped in the direction of the flow, and lapped downwards for horizontal seams. All liner terminations and leading edges shall have a 0.25-in to 0.5-inch deep by 0.125-in to 0.25-in wide saw-cuts unless otherwise specified, and shall be installed as indicated in the manufacturer’s Application Guide and detail drawings of this specification. All liner seams, terminations, and leading edges shall be sealed using the seam material. The seams and terminations shall be taped, and a seam-overlay band of seam material shall be applied as described in the Manufacturer’s Application Guide and the detail drawings of this specification. The tape shall be removed before the seam material begins to gel, in order to obtain straight edges that are free of projections. The resulting seam-overlay band shall be smooth, relatively flat, free of sharp protrusions, and have a thickness between 0.08 and 0.2 inches.

#### **Premolded PVC Corners:** Premolded PVC corners shall be installed at all inside and outside corners as indicated in the manufacturer’s Application Guide and detail drawings of this specification. PVC sheets shall overlap the PVC corners by 3 inches. The premolded PVC corners shall be pre-treated with activator on all faces before embedding them into the applied structural polymer, and applying seam material.

#### **PVC Lining U.V. Blocker:** The Contractor shall install a U.V. Blocker on all surfaces of the Protective Lining System that will be permanently exposed to sunlight. The liquid U.V. Blocker shall be applied by brush or roller to the PVC lining prior to replacing or installing the aluminum or concrete covers or other equipment. The U.V. Blocker shall be Linabond No. 55 Aliphatic Top-Coat, as manufactured by Linabond, Inc., or equal and shall be applied at the rate of 250 square feet per gallon.

### **Curing of Protective Lining System:** The finished lining shall be protected from damage during curing and shall be cured as recommended by the lining manufacturer but in all cases no less than three (3) days of curing time must elapse before the lined area can be placed into service.

## testing and inspection

### Upon completion of the installation of the protective lining system, the surface of the lining shall be cleaned and prepared to permit visual inspection, and adhesion testing by the Engineer:

#### All surfaces of the lining shall be visually inspected for areas showing poor adhesion, air inclusion, edges or seam defects, insufficient overlap, inadequate bond or any other defects in the lining preventing a complete seal of the protected surfaces.

#### To assure proper adhesion of the polyvinyl chloride lining to the structural polymer to the concrete surface, the protective lining system shall have a "pull-off test" performed at locations previously designated by the Engineer and prepared by the lining Contractor. The test shall be the "Standard Test Method for Pull-Off Strength of Coatings using Portable Adhesion Tester " per ASTM Designation D4541 and modified as follows. The 1 square inch area to be tested shall be cored through the lining system past the bond area with the concrete substrate. The allowable minimum value for the pull-off strength test shall be per the protective lining system manufacturer's recommendation but shall not be less than 40 psi after three (3) days of curing at a minimum ambient temperature of 55 F.

### Access to the protective lining system surface shall be provided by the Contractor, by leaving the installation scaffolding in place for the duration of the curing and inspection period. The areas where the destructive testing (adhesion test) was performed shall be repaired per Part 2.6 of this section.

## repair of protective lining system defects and holidays

### The Contractor shall repair entrapped air pockets in the liner greater than an equivalent area of 6-inch by 6-inch (36 sq. in), and holes or discontinuities in the liner as follows:

#### For air pockets, cut open injection and exhaust ports and inject seam material or structural polymer until the void behind the liner is completely filled. For holes or discontinuity in the liner, trim all damaged or loose PVC sheeting.

#### Clean an area extending at least 4 inches in all directions from the cut line in the PVC sheet using a clean white rag dampened with acetone to remove dirt and dust. Tape the perimeters of an area extending 4.5 inches in all direction from the cut line.

#### Apply the Surface Activator over the cleaned area.

#### Apply seam material or structural polymer at 60 to 120 mils over the activated area, and force under the loose edges of the PVC sheet.

#### Activate a PVC sheet patch large enough to cover the cut line in the air pocket with a 4-inch lap beyond the air pocket, hole or discontinuity in all directions. Apply the PVC patch over the wet seam material or structural polymer. Roll to remove entrapped air.

#### The edges of the PVC patch shall be taped leaving a ½ inch perimeter of exposed PVC. The exposed perimeter of the patch shall be activated. A 1-inch seam-overlay bead of seam material shall then be applied as described in the Manufacturer’s Application Guide and the detail drawings of this specification. The tape shall be removed before the seam material begins to gel, in order to obtain straight edges that are free of projections. The resulting seam-overlay band shall be smooth, relatively flat, free of sharp protrusions, and have a minimum average thickness between 0.08 and 0.2 inches.

### Areas where the lining adhesive strength failed to meet the minimum pull-off strength testing value specified shall have all the defective lining, including structural polymer, removed as directed by the Engineer. The area shall be relined with a new application of protective lining system, overlapping the adjacent lined areas a minimum of 4 inches in all directions and shall be re-inspected.

end of section