

E.PROTECT+ SHORING FOR COMPOSITE MEMBRANE SYSTEM FOR HYDROSTATIC WATERPROOFING AND VAPOR INTRUSION MITIGATION

SECTION 02 56 16 – GAS CONTAINMENT

SECTION 02 56 19.13 – FLUID-APPLIED GAS BARRIER

SECTION 07 13 54 – THERMOPLASTIC SHEET WATERPROOFING

SECTION 07 14 16 – COLD FLUID-APPLIED WATERPROOFING

SECTION 07 17 16 – BENTONITE COMPOSITE SHEET WATERPROOFING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the contract, including general and supplementary conditions, and Division 1 specification section, apply to this section.

1.2 SECTION INCLUDES

- A. The installation of materials designed to provide below grade waterproofing and vapor intrusion protection when installed per project specification, this section covers the waterproofing and vapor intrusion membrane, along with the following:
- B. Surface preparation and substrate treatment.
- C. Auxiliary materials.
- D. Prefabricated drainage composite.
- E. Foundation drain.

1.3 RELATED SECTIONS

- A. Section 02 24 00: Environmental Assessment
- B. Section 02 32 00: Geotechnical Investigation
- C. Section 03 15 00: Concrete Accessories
- D. Section 03 30 00: Cast-in-Place Concrete
- E. Section 03 40 00: Precast Concrete
- F. Section 07 90 00: Joint Protection
- G. Section 31 30 00: Earthwork Methods
- H. Section 33 41 00: Subdrainage

1.4 PERFORMANCE REQUIREMENTS

- A. General: Provide a composite membrane system that prevents the passage of water under hydrostatic conditions, methane gas, contaminant vapor, and complies with the physical requirements as demonstrated by testing performed by an independent testing agency.

1.5 SUBMITTALS

- A. Product Data: For each type of waterproofing specified submit manufacturer's published technical data, tested physical and performance properties, instructions for evaluating, preparing, and treating substrates, and installation instructions.
- B. Shop Drawings: Project specific drawings showing locations and extent of waterproofing, manufacturer's typical details for substrate joints and crack treatment, sheet flashing, penetrations, transitions, and termination conditions.
- C. Samples: Submit two standard size samples of each of the following:
 1. Individual components of the specified composite membrane system.
- D. Applicator Certification: Submit written confirmation at the time of bid that applicator is currently approved by the composite membrane system manufacturer.

1.6 QUALITY ASSURANCE

- A. Applicator Qualifications: Waterproofing applicator shall be an EPRO Authorized Applicator who is trained and performs work that in accordance with EPRO standards and policies. For project requiring a no-dollar-limit labor and material warranty, the waterproofing applicator must be E.Assurance Certified at the time of bid.
- B. Third Party Inspection: Independent inspection of the composite system installation may be required based on project conditions and desired warranty coverage. Inspection reports shall be submitted directly to the composite waterproofing manufacturer and made available to other parties per the owners' direction. For projects requiring a no-dollar-limit labor and material warranty, an independent inspector must be E.Assurance Certified and comply with the documentation requirements.
- C. Water Sample: A 2-liter representative ground water sample shall be sent by the installation contractor to the manufacturer, if contaminated groundwater and/or salt water is believed to be present on the site. Email Watersample@eproinc.com to receive shipping instructions.
- D. Pre-Construction Meeting: A meeting shall be held prior to application of the composite waterproofing system to assure proper substrate preparation, confirm installation conditions, and any additional project specific requirements. Attendees of the meeting shall include, but are not limited to the following:
 1. EPRO representative
 2. EPRO certified applicator
 3. EPRO certified third party inspector
 4. General contractor
 5. Owner representative
 6. Concrete/Shotcrete contractor
 7. Rebar contractor
 8. Project design team
 9. All appropriate related trades, i.e. plumbing, electrical, and mechanical contractors.

- E. Field Sample: Apply each assembly of the composite membrane system field sample to 100 ft² (9.3 m²) to demonstrate proper application techniques and establish a standard of workmanship that meets the project and manufacturer's requirements.
 - 1. Notify composite membrane system manufacturer representative, architect, certified inspector, and other appropriate parties one week in advance of the dates and times when field sample will be prepared.
 - 2. If architect and certified inspector determine that field sample does not meet requirements; reapply composite membrane system until field sample is approved.
 - 3. Retain and maintain approved field sample during construction in an undisturbed condition as a standard for judging the completed composite membrane system. An undamaged field sample may become part of the completed work.

- F. Materials: Composite membrane system and auxiliary materials shall be single sourced.

1.7 MATERIAL DELIVERY, STORAGE AND DISPOSAL

- A. Delivery: Deliver materials to site labeled with manufacturer's name, product brand name, material type, and production number. Upon the arrival of materials to the jobsite, inspect materials to confirm material has not been damaged during transit.
- B. Storage: Proper storage of onsite materials is the responsibility of the certified applicator. Consult product data sheets to confirm storage requirements. Storage area shall be clean, dry, and protected from the elements. If ambient air temperatures are expected to fall below 40°F, precautions will need to be taken to protect any polymer modified asphalt product from near freezing temperatures. Protect stored materials from direct sunlight.
- C. Disposal: Remove and replace any material that cannot be properly applied in accordance with local regulations and the general conditions found in specification section 01 74 00.

1.8 PROJECT CONDITIONS

- A. Substrate Review: Substrates shall be reviewed by the certified applicator and accepted by the certified inspector prior to application. Application without signoff from certified inspector will likely result in voidance of warranty.
- B. Penetrations: All plumbing, electrical, mechanical, and structural items to be passing through the composite membrane system shall be properly spaced, positively secured in their proper positions, and appropriately protected prior to system application and throughout the construction phase. Braided grounding rods are not allowed to pass through the membrane in waterproofing applications.
- C. Reinforcement Steel: Composite membrane system shall be installed before placement of reinforcing steel. Any anchor bolts, or other methods, of securing reinforcement steel must be in place prior to the application of the polymer modified asphalt. Piano wire, shotcrete wire rods, or similar methodologies, are prohibited from penetrating the system post installation.
- D. Clearance: Minimum clearance of 24 inches is required for application of spray applied polymer modified asphalt membrane, **e.spray**. For areas with less than 24-inch clearance, the **e.spray** membrane may be applied by hand using **e.roll**.
- E. Overspray: Protect all adjacent areas not receiving **e.spray** or **e.roll**. Masking is necessary to prevent unwanted overspray from adhering to, or staining, areas not receiving the membrane. Once **e.spray** or **e.roll** adheres to a surface it is extremely difficult to remove.

- F. Weather Limitations: Perform work only when existing and forecast weather conditions are within manufacturer's recommendations.
1. Spray Applied Polymer Modified Asphalt Membrane: Minimum ambient temperature must be 40°F (7°C) and rising. For applications temperatures below 38 degrees, but greater than +19°F/-7°C, special equipment and material handling is needed. Substrate shall be clean and free from standing moisture.
 2. EPRO applicators reserve the right not to install product when application conditions might be within manufacturer's acceptance, but ambient conditions may limit a successful application.
 3. Heat Welding: Do not weld seams during rain or periods of moisture. Sheet membranes shall be clean, and free from moisture when welding.
 4. Bentonite: Application of bentonite materials to damp surfaces is acceptable provided it is being installed over **e.spray**.

1.9 WARRANTY

- A. General Warranty: The special warranty specified in this section shall not deprive the owner of other rights the owner may have under other provisions of the contract documents, and shall be in addition to, and run concurrent with, other warranties made by the contractor under requirements of the contract documents.
- B. Special Warranty: Submit a written warranty signed by waterproofing manufacturer agreeing to replace system materials that do not conform with manufacturer's published specifications, or are deemed to be defective. Warranty does not include failure of waterproofing due to failure of soil substrate prepared and treated according to requirements or formation of new joints and cracks in the specially applied concrete that exceed 1/8 inch (3.175 mm) in width
 1. Warranty Period: 5 years after date of substantial completion. Longer warranty periods are available upon request.
 2. Coverage: Manufacturer will guarantee that the material provided is free of defects for the warranty period.
- C. Additional Warranty Options: Upgraded warranties are available by contacting the manufacturer. These warranties may have additional requirements and approval must be granted in accordance to the manufacturer's warranty requirements. Additional warranty options include:
 1. Standard Labor and Material (E.Series L&M): Manufacturer will provide non-prorated coverage for the warranty term, agreeing to repair or replace material that does not meet requirements or remain watertight.
 2. No-Dollar-Limit Labor and Material Warranty (E.Assurance NDL): Manufacturer will provide a non-prorated, no-dollar-limit, coverage for the warranty term, agreeing to repair or replace material that does not meet requirements or remain watertight.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturer: EPRO Services, Inc. (EPRO), P.O. Box 347; Derby, KS 67037; Tel: (800) 882-1896; Email: Info@eproinc.com; Web: www.eproinc.com

- B. Shoring Walls: E.Protect+ Shoring (176 mils) – **e.drain 12ds**, **e.drain 6000**, **e.base 316**, **e.spray** (80 mils), **e.shield 205b**, **e.shield bb**

2.2 SYSTEM PHYSICAL PROPERTIES

- A. The physical properties listed in this section reflect testing on the entire composite system. Physical properties of the individual system composite can be found in Specification Section 2.3.

1. **E.Protect+ Shoring** combines the redundant benefits of **e.base 316**, (16 mil HDPE thermoplastic membrane with heat welded seams), an 80 mil layer of **e.spray** (polymer modified asphaltic membrane), and e.shield 205b (an HDPE reinforced bentonite sheet). E.Protect+ shoring assembly is designed to address hydrostatic conditions in zero-lot-line applications that present significant complexity and risk.

PROPERTIES	TEST METHOD	VALUE
Tensile Strength	ASTM D412	522.7 psi
Elongation	ASTM D412	911%
Adhesion to Concrete	ASTM D903	8 lbf/in
Puncture Resistance	ASTM D1709	319.6 lbf
Hydrostatic Head Resistance	ASTM D5385	100 psi (231 ft)
Water Vapor Transmission	ASTM E96	.007 perms

2.3 WATERPROOFING MATERIALS

- A. Polymer Modified Asphalt

1. **e.spray:** **e.spray** is a non-hazardous, low-viscosity, water-based, anionic asphalt emulsion modified with a blend of synthetic polymerized rubbers and proprietary additives. **e.spray** is highly stable during transit and proper storage, but becomes highly reactive during the spray application to form a rapidly cured membrane with exceptional bonding, elongation, and hydrophobic characteristics.

PROPERTIES	TEST METHOD	VALUE
Color		Brown to Black
Solvent Content		No Solvents
Shelf Life		6 Months
Tensile Strength	ASTM D412	32 psi
Elongation	ASTM D412	4140%
Resistance to Decay	ASTM E154 Section 13	4% Perm Loss
Accelerated Aging	ASTM G23	No Effect
Moisture Vapor Transmission	ASTM E96	0.026 g/ft ² /hr
Hydrostatic Water Pressure	ASTM D751	26 psi
Perm Rating	ASTM E96	0.21 perms
Methane Transmission Rate	ASTM D1434	0
Adhesion to Concrete & Masonry	ASTM C836 & C704	20 lbf/inch
Adhesion to HDPE	ASTM C836	28.363 lbf/inch
Adhesion to Polypropylene Fabric	ASTM C836	31.19 lbf/inch
Hardness	ASTM C836	80
Crack Bridging	ASTM C836-00	No Cracking
Low Temp. Flexibility		No Cracking at -20° C
Packaging:	55 gallon drum, 275 gallon tote, 330 gallon tote	

2. **e.roll**: **e.roll** is a medium viscosity water-based, polymer-modified anionic asphalt emulsion, which exhibits exceptional bonding, elongation and waterproofing characteristics.

PROPERTIES	TEST METHOD	VALUE
Color		Brown to Black
Solvent Content		No Solvents
Shelf Life		6 Months
Tensile Strength	ASTM D412	32 psi
Elongation	ASTM D412	3860%
Resistance to Decay	ASTM E154 SECTION 13	9% Perm Loss
Accelerated Aging	ASTM G23	No Effect
Moisture Vapor Transmission	ASTM E96	0.071 g/ft ² /hr
Hydrostatic Water Pressure	ASTM D751	28 psi
Perm Rating	ASTM E96	0.17 perms
Methane Transmission Rate	ASTM D14334	0
Adhesion to Concrete & Masonry	ASTM C836	1 lbf/inch
Hardness	ASTM C836	85
Crack Bridging	ASTM C836	No Cracking
Low Temp. Flexibility	ASTM C836-00	No Cracking at -20° C
Packaging: 5 gallon bucket		

B. Thermoplastic Membrane

1. **e.base 316**: **e.base 316** is a 16 mil geomembrane comprised of high density polyethylene (HDPE). While **e.base 316** is always installed as a component of EPRO's E.Series assemblies, it alone exceeds all Class A, B, and C vapor barrier requirements.

PROPERTIES	TEST METHOD	VALUE
Material		HDPE
Color		Green
Thickness		16 mil
Classification	ASTM E1745	Exceeds Class A, B & C
Water Vapor Permeance	ASTM E96	.029 perms
Tensile Strength	ASTM E154 (ASTM D882)	63 lbf/in
Puncture Resistance	ASTM D1709 Method B	2,750 grams
Life Expectancy	ASTM E154	Indefinite
Chemical Resistance	ASTM E154	Unaffected
Dimensions: 12' x 150'		
Weight: 137 pounds		

C. Geocomposite Bentonite Membrane

1. **e.shield 205b**: **e.shield 205b** is a redundant geocomposite bentonite membrane comprised of three distinct layers, a nonwoven polypropylene geotextile, an HDPE film, and then a chemically bonded layer of sodium montmorillonite bentonite.

PROPERTIES	TEST METHOD	VALUE
Film Material		HDPE

Film Color		Gray
Fabric Material		Non-woven Polypropylene
Fabric Color		White
Bentonite		Sodium Montmorillonite (>90%)
Tensile Strength: Membrane (psi)	ASTM D882	6,100 psi (42 MPa)
% Elongation at break	ASTM D882	100%
Overall Weight		0.6 lb per ft ² (2.44 kg/m ²)
Resistance	ASTM D751 Procedure A	174 ft. (52.9 m) of water
Crack Bridging		1.8" (.032 cm) crack
Water Vapor Permeability	ASTM E96	0.53 x 10 ⁻³ cm/sec
Dimensions: 4' x 32'		
Weight: 75 pounds		

D. Prefabricated Drainage Composite

1. **e.drain 6000:** e.drain 6000 features a lightweight three-dimensional, high-compressive strength polypropylene core and bonded non-woven geotextile fabric. The bonded filter fabric allows water to pass freely into the molded drain while preventing soil particles from entering and clogging the core structure.

PROPERTIES	TEST METHOD	VALUE
DIMPLED CORE		
Core Material		Polypropylene
Color		Black
Dimple Height	ASTM D1777-96	0.4" (10.16 mm)
Compressive Strength	ASTM D6364-06	16,500 psf (790 kN/m ²)
Flow rate	ASTM D4716	21 gal/min/ft
FILTER FABRIC		
Grab Tensile	ASTM D4632-91	100 lbs
CBR Puncture resistance	ASTM D6241	250 lbs
Apparent Operating Size	ASTM D4751-99	70 sieve size (.0212 mm)
Water Flow Rate	ASTM D4491-99	140 gpm/ft ² (5704 l/min/m ²)
UV Resistance	ASTM D4355-92	70% (500 hrs)
Dimensions: 6' x 50'		
Weight: 63 pounds		

2. **e.drain 12ds:** e.drain 12ds features a lightweight three-dimensional, highly flexible polypropylene core and a non-woven geotextile filter fabric. The filter fabric is bonded to the dimples of the polypropylene core to prevent clogging within the drain.

PROPERTIES	TEST METHOD	VALUE
DIMPLED CORE		
Core Material		Polypropylene
Color		Black
Compressive strength	ASTM D1621	9,500 PSF (455 kN/m ²)
Thickness	ASTM D1777	1 Inch
Flow rate	ASTM D4716	30 gpm/ft of width
FILTER FABRIC		
CBR puncture	ASTM D6241	250 lbs
Grab tensile strength	ASTM D4632	100 lbs
AOS	ASTM D4751	70 U.S. sieve
Permitivity	ASTM D4491	2.0 sec ⁻¹

Flow rate	ASTM D4491	140 gpm/ft ²
UV resistance	ASTM D4355	70% (500 hrs)
Dimensions: 165' x 12" x 1"		
Weight: 65 pounds		

2.4 AUXILIARY MATERIALS

- A. General: All accessory products shall be provided by the specified waterproofing manufacturer. Auxiliary products used in lieu of, or in addition to, the manufacturer's products must be approved in writing by EPRO prior to installation.
- B. Reinforcement Fabric: Manufacturer's polyester fabric, **e.poly** is available in 6 inch, 12 inch, and 40 inch widths.
- C. Detailing Material: **e.roll**, a roller applied water based high viscosity polymer modified asphaltic material OR **e.trowel**, a trowel applied water based high viscosity polymer modified asphaltic material.
- D. Backer Rod: Closed cell polyethylene foam
- E. Water Stop: Water Stop: A double row **e.stop b** shall be placed at all cold joints, construction joints, penetrations, and steel beams in back lagged conditions. Water stop is not required at lift joints. A single row of **e.stop b** is acceptable at elevations above the design water table.
- F. Vertical Membrane Fastener: **e.hanger** with $\frac{3}{4}$ inch washer
- G. Termination Bar: **e.term hd**, or approved alternate
- H. Shot Pins: Minimum 1-inch galvanized steel pins with $\frac{3}{4}$ inch aluminum washer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Comply with project documents, manufacturer's product information, including product application and installation guidelines, pre-job punch list, as well as, manufacturer's shipping and storage recommendations.

3.1.2 SURFACE PREPARATION

- A. The general contractor shall engage the certified waterproofing contractor and certified inspector to ensure surfaces are prepared in accordance with manufacturer's instructions. Unless, explicitly stated in the contract documents, the waterproofing contractor is not responsible for surface preparation.
- B. Examine all substrates, areas, and conditions under which the composite membrane system will be installed, applicator and inspector must be present. Do not proceed with installation until unsatisfactory conditions have been corrected and a surface prep requirements have been met. If conditions exist that are not addressed in this section notify inspector and contact EPRO for additional clarification.

- C. Wood Lagging: Wood lagging shoring should extend to the lowest level of the waterproofing installation. Any voids or cavities exterior of the lagging timbers must be filled with compacted soil or cementitious grout. Interior surface of lagging boards should be planar with no greater than 1-inch variance in a 12-inch plane, and fit tight together with gaps less than 1 inches (25 mm). Gaps in excess of 1 inch should be filled with cementitious grout, or EPRO approved polyurethane spray foam. Marine grade plywood, or other approved surface treatment, may be used over large lagging gaps up to 6 inches, if soil conditions permit. All lagging board nails and other mechanical projections shall be removed or flattened. Install a protection material over all soldier piles with raised lagging hanger bolts, form tie rods, or other irregular surface; prefabricated drainage composite shall extend a minimum 6 inches (150 mm) to both sides of the steel piling.
- D. Shotcrete, Secant Pile, Rock Face, or Caisson Shoring Walls: Interior surface of retention walls should be planar without irregular surface conditions and a light trowel finish. Voids and sharp transitions that leave a void space to the outside of the drainage and waterproofing installation need to be filled to create a uniform and planer surface. Irregular rock and concrete, void pockets greater than 3/4" inch, cracks, sharp concave transitions should be completely filled or smoothed with cementitious grout, shotcrete, or other solid material approved by the manufacturer.
- E. Sheet Piles: Minimum ½ inch marine grade plywood must be butt jointed to form a uniform substrate that spans deviations created by the piles. Voids between the plywood and shoring shall be filled a high strength grout or other suitable material.
- F. Negative Side Internal Bracing: Internal shoring bracing, such as rakers, should be uniform and circular when interfacing with the shoring wall. Irregular bracing, such as soldier piles, creates problematic detailing and is not an approved material at the wall interface.

3.2 SHORING WALL INSTALLATION – E.PROTECT+ SHORING

- A. General: The composite membrane system shall be installed to the shoring system under strict accordance with the manufactures guideline and project specifications. This section describes the installation process for the system application to a shored wall condition.
- B. Sequencing: The first lift of the composite membrane system shall be installed prior to the placement of any concrete at the perimeter of the excavation and prior to any transition from the underslab system to vertical system. This initial drainage and underslab barrier shall extend a minimum of 4 feet past the first lift of rebar.

3.2.1 PREFABRICATED STRIP DRAIN

- A. **e.drain 12ds** is not required for projects in the water table. If required for dewatering above the water table, install **e.drain 12ds** horizontally against the shoring wall at specified elevation above the design water table. Allow for positive drainage flow into water discharge system. Attach to shoring using washered mechanical fasteners.

3.2.2 PREFABRICATED DRAINAGE COMPOSITE

- A. General: For applications to wood lagging, ½ inch cement backer board must be centered on the soldier pile and extend laterally a minimum of 6 inches past the edge of the pile flange. The board must then extend 1 foot past the intended top elevation of the pile. Cement backer board must be installed prior to the prefabricated drainage composite.
- B. Install drainage composite panels either horizontally or vertically with the geotextile fabric facing the soil retention system.
- C. Overlap seams of the drainage composite panels 6 inches and fasten **e.drain 6000** to substrate with 2-inch flat washer fasteners a minimum of every 24 inches on center on seams and terminations, and a minimum of every 48 inches on center in field.

- D. Place anchors or tie backs through the drainage composite by slitting vertically and sliding over the anchor as snug as possible.

3.2.3 THERMOPLASTIC BASE COURSE

- A. General: When tying into an underslab system extend the vertical base onto the horizontal and extend 1 foot past the inside face of the foundation wall.
- B. Install the **e.base 316** base course over the **e.base 316** by running the **e.base 316** vertically from the top of the wall to the bottom of the excavation and then extending 2 feet horizontally from the base of the wall.
- C. Overlap the seams of the **e.base 316** a minimum of 6 inches.
- D. Calibrate hot air welding equipment settings to create a continuous uniform weld free from fish mouths or deficiencies.
- E. Confirm seam overlaps are clean and dry prior to utilizing properly calibrated welding equipment to create a minimum 1 ½ inch welded seam.
- F. Secure **e.base 316** to soil retention system using **e.hanger**.
1. Install a row of **e.hanger** 3 feet on center along the bottom of the wall 3 inches from the bottom of the slab. Secure using galvanized steel pins.
 2. Alternate the next row of **e.hanger** 3 feet and 4.5 feet from the first row of **e.hanger**, and then run additional stick pins every three feet on center to the top of wall.
 3. Run an additional row of **e.hanger** 2 inches on center and placed 3 inches from planned top edge of **e.shield bb**. **e.shield bb** shall be centered over the top of slab at the bottom of wall elevation.
 4. Install **e.hanger** 2 feet on center along the seam overlap of **e.base 316**. Do not place **e.hanger** directly on a welded seam.
 5. Cut a 1 inch by ½ inch piece of **e.stop b** and press the center of the water stop through the stick **e.hanger**.
 6. Cut a minimum 6-inch patch of **e.base 316** and push it over the **e.hanger**. The ridges of the **e.base 316** shall run perpendicular to the initial base sheet for added reinforcement. Heat weld patch to underlying **e.base 316**.
- G. Corner Detail: Transition **e.base 316** through all inside corners. Corner detailing should occur in conjunction with the installation of the thermoplastic base sheet if an underslab system is used, and after the installation of the prefabricated drainage composite.
1. First Corner Target Piece: Cut a corner detailing target piece of **e.base 316** that will be placed to reinforce the corner. This detailing target piece must be a 4 feet wide. The length/height of the piece should account for the target piece extending two feet onto the horizontal underslab area and must extend a minimum of 2 feet past the first lift. It is possible to extend this target piece from the base of the wall to the top of grade, but not mandatory. The target piece shall then be folded in half along its longest edge to form a crease, and then the bottom two feet of the target piece shall be cut along the crease to create two flanges at the bottom of the sheet. Place the **e.base 316** corner target piece into the corner with 2 foot flanges extending onto the underslab area. Overlap the flanges and hot air weld together the flanges to create a 1 ½ inch continuous uniform seam free from fish mouths or deficiencies.

2. Place target piece into the corner and secure to the shoring wall using galvanized steel fasteners. Hot air weld a 6 inch by 6 inch **e.base 316** repair patch over the fasteners.
3. If necessary, extend the target piece vertically to grade or lift height. Overlap onto previously installed target piece 6 inches and hot air weld a 1 ½ inch continuous uniform seam free from fish mouths or deficiencies.
4. Install **e.base 316** on the remainder of the vertical wall to the top of the wall or previously determined height and extend over the previously installed corner detail piece. Terminate the vertically placed **e.base 316** onto the target piece 6 inches from the corner. At the base of foundation wall corner, extend **e.base 316** over the previously installed target piece and hot air weld edges to the target piece to form a 1 ½ inch continuous uniform seam free from fish mouths or deficiencies.
5. Second Corner Target Piece: Cut a corner detailing target piece of **e.base 316** that will be placed to reinforce the corner. This detailing target piece must be a 2 feet wide. The length/height of the piece should account for the target piece extending two feet onto the horizontal underslab area and must extend a minimum of 2 feet past the first lift, or top of wall. Hot air weld all overlaps to create a 1 ½ inch continuous uniform seam free from fish mouths or deficiencies
6. Do not place **e.hanger** into the corner detail. Securing of vertical sheets shall take place at the 6 inches from the corner target edge.
7. Underslab Base Sheet: Install underslab **e.base 316** and overlap onto the target sheet a minimum of 12 inches. Heat weld edges to the target piece to form a 1 ½ inch continuous uniform seam free from fish mouths or deficiencies. If rebar rods or fasteners are used to secure concrete reinforcement they shall be installed upon completion of the thermoplastic base course.

3.2.4 SEALING OF PENETRATIONS

- A. Standard Pipe Penetrations: Standard penetration detailing should occur around all penetrations that are in place prior to system application, this includes soil nails, rock anchors, and tiebacks (non-hydrostatic).
 1. Prepare penetrations so they are free of any material that will inhibit a direct bond to the penetration surface.
 2. Trim the **e.base 316** field base sheet to within 1/8 inch of the penetration.
 3. Cut target piece of **e.base 316** so that it extends a minimum of 6 inches from the base of the penetration.
 4. On the target piece create two offsetting “x” to the inside diameter of the pipe in order to create a total of 8 triangular flanges.
 5. Slide target piece over the penetration with the triangular flanges facing up.
 6. Heat weld the **e.base 316** target piece to the underlying **e.base 316** field base sheet.
 7. Apply **e.roll** between the triangular flanges and the penetration.
 8. Place a nylon cable tie around the penetration and firmly tighten around the penetration to reinforce the bond between the **e.roll**, the triangular tabs, and penetration.
 9. Tightly wrap the penetration by pressing **e.stop b** firmly around the base of the penetration.

10. Apply **e.roll** 3 inches horizontally and 3 inches vertically around the base of the penetration, encapsulating **e.stop b**.
11. Embed reinforcement fabric 3 inches horizontally and 3 inches vertically around the base of the penetration.
12. 6-inch reinforcement fabric is acceptable for most penetrations, for soil nails, rock anchors, and tiebacks (non-hydrostatic) 12-inch reinforcement fabric is required.
13. Apply a second layer of **e.roll** 3 inches to reinforcement fabric until the reinforcement fabric is fully saturated.
14. Cut a target piece of reinforcement fabric to the outside diameter of the penetration.
15. Place target piece around the penetration and embed into existing saturated reinforcement fabric, saturate fabric with **e.roll** and secure flanges to the penetration with a nylon cable tie.
16. Prior to the placement of concrete place another **e.stop b** in the middle of the wall and secure with a cable tie.

B. Tieback Covers: Tieback covers are required in hydrostatic conditions.

1. Provide at 24 inch by 24 inch block out area around all tiebacks and ensure a 6-inch minimum clearance around each tieback. The block out area must free of any material that may hinder a successful seal.
2. EPRO Tieback Cover (or galvanized steel canisters) shall be placed over the tieback and secured to the shoring.
3. Treat tieback detailing as a standard penetration.
4. Inject tieback cover with waterproof closed cell foam.

C. Rebar Rods: Rebar rods, steel fasteners, or anchor bolts used to secure concrete reinforcement shall be in place upon completion of the thermoplastic base course. No additional rebar rods, steel fasteners, or anchor bolts are to be installed after completion of the entire system.

1. Rebar rods shall be secured directly perpendicular to the vertical wall. Each rod shall be secured without the need of any additional support.
2. Install **e.stop b** around the base of the penetration.
3. Apply **e.roll** 3 inches horizontally and 3 inches vertically around the base of the penetration, encapsulating **e.stop b**.
4. Embed reinforcement fabric 3 inches horizontally and 3 inches vertically around the base of the penetration.
5. 6-inch reinforcement fabric is acceptable for most penetrations, but soil nails, rock anchors, and tiebacks (non-hydrostatic) will require 12-inch reinforcement fabric.
6. Apply a second layer of **e.roll** 3 inch to reinforcement fabric until the reinforcement fabric is fully saturated.

3.2.5 POLYMER MODIFIED ASPHALT MEMBRANE

- A. Mask off adjoining surfaces where unwanted **e.spray** polymer modified asphalt membrane may impact other construction trades.
- B. Commence application of **e.spray** when ambient air temperatures are within manufacturer recommendations.
- C. Surfaces that will receive the **e.spray** must be uniform, clean, and free from standing moisture.
- D. Start installing **e.spray** in presence of approved 3rd party inspector.
- E. Moving from the low point to the high point of the wall, apply one application of **e.spray** in accordance with manufacturer's instructions in order to obtain a seamless membrane with a minimum dry film thickness of 80 mils (2 mm).
- F. Apply **e.spray/e.roll** in and around penetrations and cavities to ensure the formation of monolithic seal around all penetrations.
- G. Apply **e.spray/e.roll** to prepared wall terminations and vertical surfaces to heights indicated according to manufacturer's recommendations and details. (if applicable)
- H. Verify film thickness of **e.spray** every 1000 ft² (93 m²).

3.2.6 GEOCOMPOSITE BENTONITE PROTECTION COURSE

- A. The previously installed membrane shall not be penetrated by any pins, nails, pencil rods, or other foreign objects.
- B. Hang **e.shield 205b** protection course vertically over nominally cured **e.spray** membrane. The gray bentonite side shall face the **e.spray**, and the geotextile fabric shall be facing away from the wall.
- C. Overlap **e.shield 205b** seams a minimum of 3 inches.
- D. Carefully press **e.shield 205b** against the wall to secure the system onto the previously installed **e.hanger**. Secure **e.shield 205b** in place with ½ inch stick pin washer. Do not place on, or below, the row of stick pins designated for the protection course.
- E. Seal the seams in order to prevent moisture from prematurely activating the bentonite layer. Either option is acceptable to the manufacturer, however any prematurely activated bentonite may be need to be replaced. The available options are as follows:
 1. Option 1: Secure the seams of **e.shield 205b** by applying 30 mils of **e.spray** in-between the seam overlap. Apply a second 30 mil layer of **e.spray** on top of the seam overlap, completely covering the seam overlap.
 2. Option 2: Apply a reinforcement detail over the **e.shield 205b** seam overlap. Apply 30 mils of **e.roll** 3 inches onto both sides of the seam overlap, center and embed 6-inch reinforcement fabric over the seam, and apply 30 mils of **e.roll** to fully saturate the reinforcement fabric.
- F. Do not penetrate or damage the composite membrane system once it has been applied. If the system is penetrated or damaged, contact the applicator immediately. Failure to bring the breach of the system to the applicator's attention and not allowing adequate time to make the necessary repair will result in voiding any warranty.

3.2.7 TERMINATION AT TOP OF GRADE

- A. The system shall extend 2 feet past the top of the wall and be temporarily secured and protected in place.
- B. When the wall is extended or a slab is placed at the top of wall, the cold joint shall be reinforced by applying 30 mils of **e.roll** on 3 inches of either side of the joint, embedding 6-inch reinforcement fabric, and then saturating the fabric with another application of 30 mils of **e.roll**.
- C. Trim the system to grade height and attach to the wall with a termination bar, **e.term hd**
- D. Apply a reinforcement detail or bead of low VOC acrylic caulking over the top of the termination bar and continue transition per project drawings.

3.2.8 WATERSTOP INSTALLATION

- A. Surface to receive waterstop shall be clean, dry, and have a smooth finish.
- B. Place two rows of **e.stop b** at minimum of 3 inches with minimum of 2 inches of coverage at all cold joints, lift joints, and concrete to steel beam connections.
- C. Place a minimum of 2 rows of **e.stop b** around all penetrations, with a minimum of 3 inch spacing, or as directed by manufacturer in specification sections that address penetrations.
- D. .

3.3 FIELD QUALITY CONTROL

- A. Destructive coupon sampling of the membrane in areas subjected to hydrostatic pressure is not allowed. Refer to manufactures target coupon sampling protocol for additional guidance.
- B. Seam Testing: Probe all welded seams using a seam probe. All deficient areas shall be noted and marked for repair, then the necessary repairs shall be made and noted in inspection reports.
- C. Independent inspectors and certified applicators shall document the gallons of **e.spray** used in the inspection report.

3.4 CURING PROTECTING AND CLEANING

- A. Allow for **e.spray** to fully bond with the substrate, generally this occurs 24 to 48 hours after application depending on ambient weather conditions.
- B. Take care to prevent contamination and damage during application stages and curing. All machinery, other trades, and general construction, shall NOT take place over the composite membrane system until inspection is complete and concrete has been placed.
- C. Prevent damage during the placement of overburden.

3.5 REPAIRS

- A. Shoring and Underslab:
 1. Inspect damaged area to determine which system components have been damaged.
 2. If the base sheet has not been compromised, patch only the areas that have been damaged by re-installing the damaged materials. The patch should extend 6 inches beyond the damaged area.

3. If the base sheet has been breached but no additional system components have been installed, install a patch below and above the base sheet that extends 6 inches beyond the damaged area. Area shall be sealed using the specified method for sealing the base sheet.
4. If the damaged area has breached the base sheet and additional components have been installed over the base sheet, the area will require removal of the overlying components to expose the base sheet.
5. If the damage is less than 3 inches, the base sheet will need to opened up to create a minimum 4-inch diameter circle to allow access Place a minimum 8-inch diameter coupon under the base sheet and seal using the specified method for seaming the base sheet. If heat welding the seam, probe the seam to ensure a uniform seal.
6. Apply a reinforcement detail of **e.roll** and reinforcement fabric 6 inches beyond the edge of the repair area.
7. Apply the remaining layers as specified.

End of Section