For more than 40 years, Carlisle has led the single-ply industry in product innovation, customer enthusiasm and system integrity.
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This specification outlines Carlisle's Sure-Seal® Underground Tanking System requirements and is intended for use as a guideline for architects/engineers when specifying an underground/tanking waterproofing assembly. While the specification contains specific installation details pertaining to various methods of membrane termination, contractors may reference other Carlisle technical publications for in-depth application procedures. Additional information pertaining to field splicing, membrane bonding and flashing of various penetrations can be found in the “Application” Section of the Carlisle Sure-Seal Adhered Roofing System Specification.

PART I     GENERAL

1.01 DESCRIPTION

The Sure-Seal Underground Tanking System incorporates 1.5 mm (.060 inch) thick Sure-Seal, black, non-reinforced or reinforced EPDM membrane. The membrane is loose laid over a geotextile separator sheet on the horizontal grade. On the vertical grade and over the geotextile separator sheet, the membrane can be mechanically fastened to a peripheral wall or directly adhered. In some applications, FleeceBACK AFX membrane can be installed horizontally and vertically in conjunction with CCW 500 Hot Rubberized Asphalt or CCW 525 Cold Applied Liquid Waterproofing Membrane. (As an option the Sure-Seal EPDM membrane can be installed on top of the CCW membranes).

All membrane splices shall be a minimum of 150 mm (6 inches) wide and assembled with Sure-Seal EP-95 Splicing Cement, In-Seam Sealant™ and Lap Sealant. As an option, Sure-Seal Pressure-Sensitive Flashing (150 mm in width) can be used as an overlayment to membrane splices.

1.02 QUALITY ASSURANCE

A. The Sure-Seal 1.5 mm (.060") thick, non-reinforced EPDM membrane meets ASTM D6134-97, Standard Specification for Vulcanized Rubber Sheets Used in Waterproofing Systems.

<table>
<thead>
<tr>
<th>Property</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tensile Strength</td>
<td>ASTM D412, Die C</td>
</tr>
<tr>
<td>Elongation, Ultimate</td>
<td>ASTM D412, Die C</td>
</tr>
<tr>
<td>Tensile Set</td>
<td>ASTM D412, Method A, Die C, % Elongation</td>
</tr>
<tr>
<td>Tear Resistance</td>
<td>ASTM D624, Die C</td>
</tr>
<tr>
<td>Brittleness Temperature</td>
<td>ASTM D746</td>
</tr>
<tr>
<td>Linear Dimensional Change</td>
<td>ASTM D1204, 166 h @ 240º F ± 4º F</td>
</tr>
<tr>
<td>Water Absorption</td>
<td>ASTM D471, @ 70º C ± 2º C (158º F ± 4º F) for 166 h</td>
</tr>
<tr>
<td>Factory Seam Strength</td>
<td>ASTM D816, Modified Method B, 1” wide, 2”/min.</td>
</tr>
<tr>
<td>Water Vapor Permeance</td>
<td>ASTM E96, Procedure B W relative humidity of 45% @ 70º F ± 4º F</td>
</tr>
<tr>
<td>Hardness Durometer A</td>
<td>ASTM D2240</td>
</tr>
<tr>
<td>Resistance to Soil Burial</td>
<td>ASTM D3083</td>
</tr>
<tr>
<td>Resistance to Heat Aging</td>
<td>ASTM D573, Properties after 166 h @ 240º F ± 4º F</td>
</tr>
<tr>
<td>Test Resistance to Puncture</td>
<td>ASTM E154</td>
</tr>
</tbody>
</table>

Refer to the physical property chart included in the “Product Section” for actual values achieved.

B. This Underground Tanking System must be installed by an Authorized Applicator and in compliance with Carlisle’s installation details and project specification as approved by Carlisle. Deviations from Carlisle's details or approved specification shall be secured in writing prior to commencement of work.

C. Prior to installation, project shop drawings may be submitted to the manufacturer for review and approval. Copies of the approved shop drawing should be made available to the project architect/engineer upon request.

D. Comply with applicable regulatory requirements and applicable codes, ordinances, regulations and laws.  

E. On-site technical assistance is available for a charge. Projects where technical assistance is required must have a manufacturer’s approved drawing.

1.03 SUBMITTALS

A. To ensure compliance with the applicable design criteria, project drawings, specification and pertinent details may be submitted for Carlisle’s review.

B. Requests for certification and/or formal drawing approval must be accompanied by a copy of the project specification and details. Shop drawings of maximum size 43 cm x 56 cm (17” x 22”) are preferred.

C. Substitution of a non-Carlisle supplied product is permitted upon review and approval. Samples of the product along with technical literature may be forwarded to Carlisle for consideration.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver materials to the job site in the original, unopened containers labeled with the manufacturer's name, brand name and installation instructions.

B. Job site storage temperatures in excess of 32°C (90°F) may affect shelf life of curable materials (i.e., adhesive, sealants and cleaners).

C. When sealants or cleaners are exposed to lower temperatures, restore to minimum 16°C (60°F) before use.

1.05 JOB CONDITIONS

A. The EPDM membrane resists a wide variety of chemicals. Depending upon level of concentration and temperature, the membrane performance will vary. The chemical resistance chart of Sure-Seal EPDM shows compatibility of the membrane with various chemicals that normally exist in the soil. Should there be severe soil conditions not shown in the chart, a soil test shall be reviewed by Carlisle for compatibility.

B. Comply with applicable codes and regulations pertaining to the operation and storage of heavy equipment.

C. Coordination between various trades is essential to avoid unnecessary traffic over sections of already installed membrane to prevent damage to the waterproofing membrane.

D. Do not install membrane onto low melting point asphalt (ASTM D 312 Type I and II) with a softening point below 85°C (185°F).

E. Do not allow waste products (i.e., petroleum, grease, oil, solvents, vegetable or mineral oil, animal fat) or direct steam venting to come in contact with the waterproofing membrane.

F. Do not expose membrane and accessories to constant temperatures in excess of 82°C (180°F).

G. Prior to the use of any product, consult the Material Safety Data Sheet and Technical Data Bulletin for cautions and warnings. Store adhesives, sealants and cleaners away from all sources of heat, flame or sparks. Do not use in confined or unventilated areas.

H. Cold temperatures will not restrict installation of the Sure-Seal Underground Tanking System. Follow specified precautions for storage of materials. Expose only enough cements/adhesives to be used within a 4 hour period.

I. Splicing and bonding surfaces should be dry and clean.

J. Substrate shall be free of ponded water, ice or snow.

K. Coordinate waterproofing work with other trades. The applicator shall have sole right of access to the specified areas for the time needed to complete the application and allow the membrane to cure adequately.
L. Maintain work area neat and orderly condition, removing empty containers, rags and debris daily from the site.

1.06 WARRANTY

A 20 year Membrane Material Warranty is available for a charge. The Material Warranty will cover normal deterioration and is pro-rated.

PART II PRODUCTS

2.01 GENERAL

The components of this Underground Tanking System are to be products of Carlisle or accepted by Carlisle as compatible. The installation, performance or integrity of products by others, when selected by the specifier and accepted as compatible by Carlisle, is not the responsibility of Carlisle.

2.02 MEMBRANE

A. Sure-Seal (black) 1.5 mm (.060") thick non-reinforced EPDM (Ethylene, Propylene, Diene Terpolymer) membrane; maximum 15.2 m (50') wide, maximum 30.5 m (100') long which meets ASTM D6134-97. Sure-Seal 1.1 mm (.045") thick non-reinforced membrane is also available in 61 m (200') lengths.

<table>
<thead>
<tr>
<th>Physical Property</th>
<th>Test Method</th>
<th>SPEC. (Pass)</th>
<th>Typical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tolerance on Nominal Thickness, %</td>
<td>ASTM D 412</td>
<td>±10</td>
<td>±10</td>
</tr>
<tr>
<td>Tensile Strength, min, psi (MPa)</td>
<td>ASTM D 412</td>
<td>1305 (9)</td>
<td>1630 (11.2)</td>
</tr>
<tr>
<td>Elongation, Ultimate, min, %</td>
<td>ASTM D 412</td>
<td>350</td>
<td>520</td>
</tr>
<tr>
<td>Tear Resistance, min, lbf/in (kN/m)</td>
<td>ASTM D 624 (Die C)</td>
<td>175 (30.6)</td>
<td>230 (40.3)</td>
</tr>
<tr>
<td>Factory Seam Strength, min.</td>
<td>Modified ASTM D 816</td>
<td>Membrane Rupture</td>
<td>Membrane Rupture</td>
</tr>
<tr>
<td>Resistance to Heat Aging* Properties</td>
<td>ASTM D 573</td>
<td></td>
<td></td>
</tr>
<tr>
<td>after 4 weeks @ 240°F (116°C)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tensile Strength, min, psi (MPa)</td>
<td>ASTM D 412</td>
<td>1205 (8.3)</td>
<td>1500 (10.3)</td>
</tr>
<tr>
<td>Elongation, Ultimate, min, %</td>
<td>ASTM D 412</td>
<td>225</td>
<td>310</td>
</tr>
<tr>
<td>Tear Resistance, min, lbf/in (kN/m)</td>
<td>ASTM D 624</td>
<td>150 (26.3)</td>
<td>215 (37.6)</td>
</tr>
<tr>
<td>Linear Dimensional Change, max, %</td>
<td>ASTM D 1204</td>
<td>±1.0</td>
<td>-0.4</td>
</tr>
<tr>
<td>Resistance to Outdoor (Ultraviolet)</td>
<td>ASTM D 746</td>
<td>-75 (-59)</td>
<td>-85 (-65)</td>
</tr>
<tr>
<td>Weathering*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>After 7 days immersion @ 104°F (40°C)</td>
<td>ASTM D 471</td>
<td>+4.0</td>
<td>+2.0</td>
</tr>
<tr>
<td>Change in mass, max, %</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water Vapor Permeance* max, perm</td>
<td>ASTM E 96 (Proc. B or BW)</td>
<td>0.1</td>
<td>.05</td>
</tr>
<tr>
<td>Resistance to Outdoor (Ultraviolet)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weathering*</td>
<td>ASTM D G-26</td>
<td>No Cracks</td>
<td>No Cracks</td>
</tr>
<tr>
<td>Xenon-Arc, 7560 kJ/m² total radiant</td>
<td></td>
<td>No Crazing</td>
<td>No Crazing</td>
</tr>
<tr>
<td>exposure at .70 W/m irradiance, 176°F</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(80°C) black panel temp.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Not a Quality Control Test due to the time required for the test or the complexity of the test. However, all tests are run on a statistical basis to ensure overall long-term performance of the sheeting.
B. **Sure-Seal (black) 1.5 mm (.060") thick reinforced EPDM** (Ethylene, Propylene, Diene Terpolymer) membrane; maximum 3.1 m (10') wide, maximum 30.5 m (100') long that meets ASTM D4637-96.

**.060" THICK REINFORCED EPDM MEMBRANE**

<table>
<thead>
<tr>
<th>Physical Property</th>
<th>Test Method</th>
<th>SPEC.(Pass)</th>
<th>Typical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tolerance on Nominal Thickness, %</td>
<td>ASTM D 751</td>
<td>±10</td>
<td>±10</td>
</tr>
<tr>
<td>Thickness Over Scrim, min, in. (mm)</td>
<td>ASTM D 4637 Annex</td>
<td>.015 (.381)</td>
<td>.045&quot;-.016 (.406) .060&quot;-.020 (.508)</td>
</tr>
<tr>
<td>Breaking Strength, min, lbf (N)</td>
<td>ASTM D 751 Grab Method</td>
<td>90 (400)</td>
<td>180 (800)</td>
</tr>
<tr>
<td>Elongation, Ultimate, min, %</td>
<td>ASTM D 751 Grab Method</td>
<td>250 **</td>
<td>500 **</td>
</tr>
<tr>
<td>Tear Strength, min, lbf(N)</td>
<td>ASTM D 751 B Tongue Tear</td>
<td>10 (45)</td>
<td>30 (132)</td>
</tr>
<tr>
<td>Brittleness point, max, deg. F (deg. C) *</td>
<td>ASTM D 2137</td>
<td>-49 (-45)</td>
<td>-75 (-59)</td>
</tr>
<tr>
<td>Resistance to Heat Aging *</td>
<td>ASTM D 573</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Properties after 4 weeks @ 240°F</td>
<td>ASTM D 751</td>
<td>80 (355)</td>
<td>175 (780)</td>
</tr>
<tr>
<td>Breaking Strength, min, lbf (N)</td>
<td>ASTM D 751</td>
<td>200 **</td>
<td>250 **</td>
</tr>
<tr>
<td>Elongation, Ultimate, min, %</td>
<td>ASTM D 1204</td>
<td>±1.0</td>
<td>-0.7</td>
</tr>
<tr>
<td>Linear Dimensional Change, max, %</td>
<td>ASTM D 1149</td>
<td>No Cracks</td>
<td>No Cracks</td>
</tr>
<tr>
<td>Ozone Resistance*</td>
<td>ASTM D 471</td>
<td>+4.0 **</td>
<td>+2.0 **</td>
</tr>
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<td>Condition after exposure to 100 pphm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ozone in air for 168 hours @ 104° F</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Specimen wrapped around 3&quot; mandrel</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Resistance to Water Absorption*</td>
<td>ASTM D G-26</td>
<td>No Cracks</td>
<td>No Crazing</td>
</tr>
<tr>
<td>After 7 days immersion @ 158°F (70°C)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Change in mass, max, %</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| Xenon-Arc, 7560 kJ/m² total radiant exposure at .70 W/m² radian
c | AST |  |  | |

* Not a Quality Control Test due to the time required for the test or the complexity of the test. However, all tests are run on a statistical basis to ensure overall long-term performance of the sheeting.

** Specimens to be prepared from coating rubber compound, vulcanized in a similar method to the reinforced product.

C. **FleeceBACK AFX Membrane** (optional membrane occasionally specified for use with CCW 500 Liquid Applied Membrane): 1.1 mm (45 mils) thick Sure-Seal (black) non-reinforced EPDM laminated to 212 grams (7.5 ounce) per .83 square meter (1 square yard), non-woven polyester, polypropylene blended fleece-backing resulting in a total finished sheet thickness of 2.3 mm (90 mils). A selvage edge is provided on one edge along the length of the membrane for membrane splicing. Membrane is available in widths of 3 m (10 feet) and lengths of 15.2 or 30 m (50 or 100 feet) and conforms to ASTM Standard D4637-96, Type III (Fabric-backed membrane) with the following physical properties:
### Physical Property

<table>
<thead>
<tr>
<th>Property</th>
<th>Test Method</th>
<th>SPEC.(Pass)</th>
<th>Typical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tolerance on Nominal Thickness, %</td>
<td>ASTM D 751</td>
<td>±10</td>
<td>±10</td>
</tr>
<tr>
<td>Thickness over Fleece, min. in. (mm)</td>
<td>ASTM D4637 Annex</td>
<td>0.030 (0.762)</td>
<td>0.045 (1.143)</td>
</tr>
<tr>
<td>Weight 1b/ft² (kg/m²)</td>
<td></td>
<td>0.29 (1.4)</td>
<td></td>
</tr>
<tr>
<td>Breaking Strength, min. lbf (N)</td>
<td>ASTM D751 Grab Method</td>
<td>90 (400)</td>
<td>200 (890)</td>
</tr>
<tr>
<td>Elongation, Ultimate, min. %</td>
<td>ASTM D 412</td>
<td>300 **</td>
<td>500 **</td>
</tr>
<tr>
<td>Tearing Strength, min. lbf (N)</td>
<td>ASTM D 751</td>
<td>10 (45)</td>
<td>45 (200)</td>
</tr>
<tr>
<td>Brittleness point, max. °F (°C)</td>
<td>ASTM D 2137</td>
<td>-49 (-45)</td>
<td>-75 (-59)</td>
</tr>
<tr>
<td>Resistance to Heat Aging *</td>
<td>ASTM D 573</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Properties after 4 weeks @ 240°F (116°C) for Sure-Seal</td>
<td>ASTM D 751</td>
<td>80 (355)</td>
<td>200 (890)</td>
</tr>
<tr>
<td>Breaking Strength, min. lbf (N)</td>
<td>ASTM D 412</td>
<td>200 **</td>
<td>310 **</td>
</tr>
<tr>
<td>Elongation, Ultimate, min. %</td>
<td>ASTM D 1204</td>
<td>±1.0</td>
<td>-0.7</td>
</tr>
<tr>
<td>Ozone Resistance *</td>
<td>ASTM D 1149</td>
<td>No Cracks</td>
<td>No Cracks</td>
</tr>
<tr>
<td>Condition after exposure to 100 ppm Ozone in air for 168 hours @ 104°F (40°C) Specimen wrapped around 3 inch (7.5 cm) mandrel</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Resistance to Water Absorption *</td>
<td>ASTM D 471</td>
<td>4.0 **</td>
<td>2.0 **</td>
</tr>
<tr>
<td>Change in mass, max. %</td>
<td>ASTM G 26</td>
<td>No Cracks</td>
<td>No Crazing</td>
</tr>
<tr>
<td>Resistance to Outdoor (Ultraviolet) Weathering *</td>
<td>ASTM D 1653</td>
<td>No Cracks</td>
<td>No Crazing</td>
</tr>
<tr>
<td>Xenon-Arc, 7560 kJ/m  total radiant exposure at 0.70 W/m² 176°F (80°C) black panel temperature</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dynamic Puncture Resistance (foot pounds)</td>
<td>ASTM D 5635</td>
<td>&gt;35</td>
<td></td>
</tr>
</tbody>
</table>

**Not a Quality Control Test due to the time required for the test or the complexity of the test. However, all tests are run on a statistical basis to ensure overall long-term performance of the sheeting.**

**Specimens prepared from coating rubber compound.**

C. **CCW-525 (Cold Applied) Liquid Waterproofing Membrane** (optional membrane used when specified): A liquid-applied, single-component, moisture cured, elastomeric, coal-tar free, modified polyurethane which cures to form a flexible, monolithic, waterproof membrane on vertical or horizontal surfaces, above or below grade. Applied on vertical surfaces using a trowel or roller, and on horizontal surfaces using a notched squeegee (self-leveling). The membrane has tenacious adhesion to concrete substrates preventing lateral water migration. The average thickness is 1.4 mm (.055”). Packaged in 19 l (5 gallon) pails or 208 l (55 gallon) drums.

<table>
<thead>
<tr>
<th>Property</th>
<th>Test Method</th>
<th>Typical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Composition</td>
<td></td>
<td>Modified Polyurethane</td>
</tr>
<tr>
<td>Color</td>
<td></td>
<td>Black</td>
</tr>
<tr>
<td>Tack Free Time *</td>
<td></td>
<td>16 hours</td>
</tr>
<tr>
<td>Cure Time *</td>
<td></td>
<td>36 hours</td>
</tr>
<tr>
<td>Solids Content</td>
<td>ASTM D 1353</td>
<td>85 +/- 2%</td>
</tr>
<tr>
<td>Hardness</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Horizontal</td>
<td>ASTM D 2240</td>
<td>35 Shore A</td>
</tr>
<tr>
<td>Vertical</td>
<td>ASTM D 2240</td>
<td>42 Shore A</td>
</tr>
<tr>
<td>Elongation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Horizontal</td>
<td>ASTM D 412</td>
<td>500%</td>
</tr>
<tr>
<td>Vertical</td>
<td>ASTM D 412</td>
<td>500%</td>
</tr>
<tr>
<td>Tensile</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Horizontal</td>
<td>ASTM D 412</td>
<td>350 psi (2.4 MPa)</td>
</tr>
<tr>
<td>Vertical</td>
<td>ASTM D 412</td>
<td>350 psi (2.4 MPa)</td>
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<tr>
<td>Modulus at 100% Elongation</td>
<td>ASTM D 412</td>
<td>75 psi (0.52 MPa)</td>
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<tr>
<td>Permeability (60 mils thick)</td>
<td>ASTM D 1653</td>
<td>0.10 perms</td>
</tr>
<tr>
<td>Adhesion to Primed Concrete</td>
<td>ASTM D 903</td>
<td>20 lbs/in width (3.6 kg/cm width)</td>
</tr>
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- Values typical at standard conditions: 24°C (75°F), 50% RH.
D. CCW 500 (Hot Rubberized Asphalt) Liquid Waterproofing Membrane (optional membrane used in conjunction with FleeceBACK AFX Membrane when specified): A single-component, rubberized asphalt compound that forms a tough, flexible, thick waterproofing membrane. Used in conjunction with FleeceBACK AFX membrane. It’s rubber-like properties provide a self-healing characteristic which helps ensure waterproofing integrity. It adheres to any vertical or horizontal surface to assure water will not migrate beneath the membrane in the event of physical damage. Packaged in 20.4 kg (45 pound) blocks, one block per carton, 64 cartons per pallet.

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<tr>
<th>Property</th>
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<tr>
<td>Solids Content</td>
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<tr>
<td>Flow</td>
<td>ASTM D 1191</td>
<td>140°F, 0 mm</td>
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<tr>
<td>Penetration (1/10th mm)</td>
<td>ASTM D 1191</td>
<td>@ 77°F – Avg. 76</td>
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<tr>
<td></td>
<td></td>
<td>@ 122°F – Avg. 159</td>
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<tr>
<td>Flash Point</td>
<td>ASTM D 92</td>
<td>568°F</td>
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<tr>
<td>Water Vapor Permeance</td>
<td>ASTM F 96(E)</td>
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<td>Ratio of Toughness to peak load</td>
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<tr>
<td>Adhesion</td>
<td>CGSB-37.50-M89</td>
<td>Pass</td>
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<tr>
<td>Softening</td>
<td>ASTM D 36</td>
<td>208°F</td>
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<td>Viscosity</td>
<td>CGSB-37.50-M89</td>
<td>3 seconds 980 cps @ 400°F</td>
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<tr>
<td>Water Absorption</td>
<td>CGSB-37.50-M89</td>
<td>96 hrs. - 0.05 g</td>
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<td>(max. 0.35 g (gain))</td>
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<td>Pinholing</td>
<td>CGSB-37.50-M89</td>
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<tr>
<td>Low temperature flexibility</td>
<td>CGSB-37.50-M89</td>
<td>No cracks or loss of adhesion</td>
</tr>
<tr>
<td>Low temperature crack bridging</td>
<td>CGSB-37.50-M89</td>
<td>No cracks, splitting or loss of adhesion</td>
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<tr>
<td>Heat stability</td>
<td>CGSB-37.50-M89</td>
<td>No change in viscosity, penetration, flow or low temperature after aging.</td>
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<tr>
<td>Resistance to mild acids</td>
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<td>No effect</td>
</tr>
<tr>
<td>Minimum ambient temperature for application</td>
<td>ASTM D 36</td>
<td>0°F</td>
</tr>
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</table>

2.03 FLASHING

A. Sure-Seal Uncured EPDM Elastoform Flashing®: An easily formed, 1.5 mm (.060") thick Sure-Seal (black) uncured EPDM membrane available in widths of 15.2 cm, 22.9 cm, 30.5 cm, and 45.7 cm (6", 9", 12" and 18") and lengths of 30.5 m (100’). Sure-Seal Elastoform Flashing is also available in a 61 cm (24") width.

B. Sure-Seal Pressure-Sensitive Uncured Flashing: A 150 mm (6") wide, .040" thick uncured EPDM Flashing laminated to a 30 mil pre-applied adhesive tape used to overlay splices if required.

2.04 CLEANERS, PRIMERS, ADHESIVES AND SEALANTS

A. Sure-Seal Splice Cleaner or Weathered Membrane Cleaner: A black, solvent-based cleaner used to remove dust, dirt or other contaminants prior to applying Splicing Cement and Lap Sealant.

B. Sure-Seal EP-95 Splicing Cement: A black, high-strength, butyl-based contact cement that is used for splicing adjoining sections of EPDM membrane (cured or uncured).

C. Sure-Seal In-Seam Sealant: A one-part, gun-consistency sealant applied in adhesive splices between cured Sure-Seal EPDM membrane sections.

D. Sure-Seal Lap Sealant: A black, heavy-bodied material (trowel or gun-consistency) used to seal the exposed edges of a membrane splice. A pre-formed Lap Sealant tool is included in each carton of Lap Sealant.

E. Sure-Seal SecurTAPE™: 7.6 cm (3 inch) wide by 30.5 m (100 foot) long splice tape used to splice adjoining sheets together. Complies with the U.S. South Coast Air Quality Management District Rule 1168.

F. Sure-Seal HP-250 Primer: A solvent-based primer used to prepare the surface of EPDM membrane for application of Splice Tape or Pressure-Sensitive products. This Primer can also be used in conjunction with EP-95 Splicing Cement in lieu of Splice Cleaner or Weathered Membrane Cleaner.

G. CCW-550 Primer: A single component, solvent-based bituminous primer especially designed to promote adhesion of the CCW-500 Hot Applied Liquid Membrane by preparing the concrete surface. Packaged in 19 l (5 gallon) pails and 208 l (55 gallon) drums.
H. **Sure-Seal 90-8-30A Bonding Adhesive:** A high-strength, yellow colored, synthetic rubber adhesive used for bonding Sure-Seal EPDM membranes to various surfaces.

I. **Water Cut-Off Mastic:** A one-component, low viscosity, self-wetting, Butyl blend mastic used as a sealing agent between the EPDM membrane or Elastoform® Flashing and applicable substrates.

J. **CCW-201 Sealant:** A multi-component, chemical curing, low modulus, non-sag, polyurethane sealant specially formulated for dynamically moving joints. The sealant is used at all expansion joints and at the base of walls in conjunction with CCW 500 Hot Rubberized Asphalt and CCW-525 (Cold Applied) Liquid Waterproofing Membranes in high water table conditions and is designed to provide long term performance +50% movement capability and excellent weathering characteristics.

### 2.05 FASTENING COMPONENTS

A. **Termination Bar:** A 2.5 cm (1 inch) wide and 2.5 mm (.098 inch) thick extruded aluminum bar pre-punched 15.2 cm (6 inches) on center which incorporates a sealant ledge to support Lap Sealant and provide increased stability for membrane terminations.

B. **HP CD-10 Concrete Spike:** A hammer-driven, non-threaded, black epoxy electro-deposition coated (E-Coat) fastener for use with structural concrete rated 211 kg/cm² (3,000 psi) or greater.

C. **HD 14-10 Concrete Fastener:** A #14 threaded fastener used for minimum 211 kg/cm² (3,000 psi) structural concrete.

### 2.06 OTHER PRODUCTS

A. **HP Splice Wipes:** Used in conjunction with Splice Cleaners or HP-250 Primer to clean membrane prior to splicing or applying Lap Sealant.

B. **Protection Fabric:** A non-woven, polypropylene, geotextile fabric that is used as a protection layer above the waterproofing membrane and as a separation below the membrane. The fabric acts as a filter through which water passes to promote drainage. Material weight when used as a separation layer shall be 150 g/m² and 250 g/m² when used as a protection layer.

C. **Sure-Board (Protection Board):** A 3 mm (1/8") thick, non-compressible, lightweight and flexible protection board used for maximum protection of waterproofing membrane during and after backfilling. The Sure-Board is available in 125 cm x 250 cm (4 x 8 feet).

D. **Water Swelling Waterbar (by others):** Used to provide efficient waterproofing of construction joints. When in contact with water, the waterbar will slowly increase in volume (20% to 200% depending on water salt concentration). The swelling action (limited to the side exposed to water) will cause the waterbar to profile itself into the joint filling all cavities and effectively stop water seepage. For added safety, wider joints can be filled using 2 waterbars. The Water Swelling Waterbar is used at the top of pilings around rebars and other joints in the peripheral walls.

E. **Capillary Waterproofing Compound (by others):** A dry mixture compound that forms a waterproofing System when mixed with water. The compound is applied directly to concrete in areas where general waterproofing is required and ensures a permanent solution to water leakage or seepage. The formation and development of insoluble crystals into water bearing capillaries effectively blocks the further passage of water and ensures water tightness. The product is used to treat the top of the piling to effectively ensure water tightness around reinforcing bars and at angle changes where high hydrostatic pressure may promote seepage during installation.
PART III  EXECUTION

3.01  GENERAL

A. Refer to the applicable Material Safety Data Sheets and Technical Data Bulletins for cautions and warnings.

B. Comply with the manufacturer’s published instructions for the installation of the Underground Tanking System including proper substrate preparation, jobsite considerations and weather restrictions.

3.02  SUBSTRATE PREPARATION

A. On horizontal applications, new concrete blinding shall be relatively even and water cured, with a light-hair broom finish and in place for a minimum of 72 hours.

B. Sweep all loose debris from the concrete blinding tanking substrate prior to application of waterproofing membrane.

C. Remove splatters, fins, ridges or other projections to provide a level vertical or horizontal surface. Fill holes, honeycombs, rock pockets, spalls or other voids and indentations with approved concrete patching compound.

D. Grind or fill surface at cold joints where each concrete pour is at a different plane to provide a smooth and level surface.

E. All surfaces shall be structurally sound, dry and free of dust, dirt and frost. Non-approved curing agents or other contaminates that may affect adhesion of the membrane must also be removed.

F. On peripheral walls, when specified, apply capillary waterproofing treatment to all vertical surfaces to facilitate proper membrane adhesion.

G. In lieu of capillary waterproofing treatment of walls, a liquid waterproofing membrane can be specified in conjunction with EPDM membrane in special conditions. When a liquid waterproofing membrane is specified, mix CCW-201 Sealant and apply to all expansion joints and at the base of walls to form a 45° cant.

3.03  APPLICATION OF LIQUID WATERPROOFING MEMBRANE (WHERE APPLICABLE)

Liquid Waterproofing Membrane is used in conjunction with FleeceBACK AFX membrane as an option to Sure-Seal EPDM. The project architect/engineer may select either CCW-500 Hot Rubberized Asphalt or CCW-525 Cold Applied Liquid Waterproofing Membrane.

A. CCW-500 Hot Applied Liquid Waterproofing Membrane

1. Melt blocks of CCW-500 in a twin wall kettle with continuous agitation.

   CAUTION: Do not exceed maximum safe operating temperature of 204° C (400° F). Use with adequate ventilation. Workers must use proper protection to prevent burns.

2. Apply a thin, even coat of CCW-550 Primer over the entire surface to receive waterproofing. Apply at the rate of 123-183 m² (400 – 600 square feet) per 3.78 l (1 gallon). Allow the primer to dry.

   Note: Liquid membrane will not properly adhere to wet primer.

3. Apply CCW-500 Hot Applied Membrane to the primed surface at a rate of 1.86 m² (20 square feet) per 3.78 l (1 gallon) for a 3.8 mm (150 mil) system or 1.67 m² (18 square feet) per 3.78 l (1 gallon) for thicker systems.

4. Allow liquid membrane to cure for a 24 hour period at 24° C (75° F) prior to installation of EPDM membrane. Protect the liquid applied membrane with a protection board if the EPDM membrane will not be installed after a 24 hour curing time.
B. **CCW-525 Cold Applied Liquid Waterproofing Membrane**

1. Using a notched squeegee, apply CCW-525 horizontal self-leveling grade waterproofing over the smoothly finished, plain, concrete blinding at a rate of 2.3 m² (25 square feet) per 3.78 l (1 gallon) to achieve an average thickness of 1.4 mm (.055 inches).

   **CAUTION:** CCW-525 is a combustible liquid and vapor. Keep away from heat and flame. Use only with adequate ventilation. Avoid contact with the eyes or skin, especially open breaks in the skin.

2. Once the membrane has cured for a period of 36 hours at 24° C (75° F), install Sure-Seal 1.5 mm (.060 inch) thick non-reinforced EPDM membrane as outlined in Paragraph 3.05 below. Protect the liquid applied membrane with a protection board if the EPDM membrane will not be installed after a 36 hour curing time.

3.04 **APPLICATION OF SEPARATION LAYER**

A. A geotextile separation layer (150 g/m² minimum) can be used in lieu of cold or hot liquid waterproofing below the membrane.

B. Install the geotextile fabric loose laid over the concrete blinding substrate and overlap adjoining sheets a minimum of 15 cm (6 inches).

3.05 **APPLICATION OF SURE-SEAL 1.5 mm (.060 inch) THICK EPDM MEMBRANE**

A. Substrate must be clean, smooth, dry and free of projections (i.e., fins, sharp edges), contaminants, foreign material, oil and grease.

B. Unroll EPDM membrane without stretching and allow to relax approximately 1/2 hour.

C. **Horizontal membrane application**

   1. The membrane shall be installed loose-laid over the geotextile fabric or the liquid waterproofing membrane.

   2. Membrane overlap shall be 15 cm (6 inches) to provide for the minimum splice width. Refer to Paragraph 3.06 for membrane splicing procedures.

D. **Vertical membrane application**

   The membrane can be adhered or loose laid with mechanical fastening to the substrate.

   1. **For mechanically fastened membrane**, the membrane shall be secured every 3 m (10 feet) vertically with Sure-Seal Termination Bars or with a horizontal RUSS (Reinforced Universal Securement Strip).

      Sure-Seal Termination Bars shall be installed in conjunction with Sure-Seal Water Cut-Off Mastic and fastened utilizing Concrete Fasteners spaced a maximum of 30 cm (12 inches) on center.

   2. **For adhered membrane**:

      a. Stir Bonding Adhesive thoroughly scraping the sides and the bottom of the can (minimum 5 minutes stirring is recommended). Bonding surfaces must be dry and clean.

      b. Apply 90-8-30A Bonding Adhesive evenly, without globs or puddles with a plastic core medium nap paint roller. A 23 cm (9 inch) roller will easily fit into the 19 l (5 gallon) containers.

      c. Apply 90-8-30A Bonding Adhesive to both the membrane sheet and the substrate to achieve continuous coating of both surfaces at a coverage rate of approximately 11.2 m² (120 square feet) per 3.78 l (1 gallon) per one surface (membrane or substrate) or approximately 5.6 m² (60 square feet) per 3.78 l (1 gallon) per finished surface (includes coverage on both membrane and substrate).

      If a mechanical sprayer is used to apply Bonding Adhesive, the adhesive must be rolled after spraying with a plastic core medium nap paint roller to provide continuous coverage.
CAUTION: Due to solvent flash off, condensation may form on freshly applied Bonding Adhesive when the ambient temperature is near the dew point. If condensation develops, possible surface contamination may occur and the application of Bonding Adhesive must be discontinued. Allow the surface to dry and apply a thin freshener coat at the coverage rate that is approximately half of the coverage rate stated above to the previously coated surface when conditions allow for continuing.

d. **Allow** adhesive to dry until it is tacky but will not string or stick to a dry finger touch.

e. **Roll** the coated membrane into the coated substrate while avoiding wrinkles.

f. **Brush** down the bonded half of the membrane sheet, immediately after rolling the membrane sheet into the adhesive, **with a soft bristle push broom** to achieve maximum contact.

g. **Install** adjoining membrane sheets in the same manner, overlapping edges approximately 15 cm (6 inches) to provide for the minimum splice width.

### 3.06 APPLICATION OF FLEECEBACK AFX MEMBRANE (OPTIONAL)

A. FleeceBACK AFX membrane in conjunction with Liquid Waterproofing Membrane can be used as an option in lieu of Sure-Seal EPDM.

B. When positioning FleeceBACK AFX membrane along the length for splice tape or adhesive splices. At end laps, butt edges of membrane together and overlay with 6 inch wide Pressure-Sensitive Cured Cover Strip.

### 3.07 EPDM MEMBRANE SPLICING

A. Adhesive splices must be a minimum of 15 cm (6 inches) wide.

B. Remove dirt or excess dust from the mating surfaces of the overlapping sheets by wiping with Sure-Seal HP Splice Wipes or clean natural fiber rags. The splice area of both membrane sheets must be cleaned by scrubbing with Splice Wipes or clean natural fiber rags saturated with Sure-Seal Splice Cleaner, Weathered Membrane Cleaner or HP-250 Primer. Extra cleaning is required along a factory seam that intersects a splice area.

C. When cleaning the membrane surface as stated above, check the membrane surfaces to verify adequate cleaning procedures are maintained. Both sides of the **Sure-Seal EPDM membrane** must be solid black in color with no streaking. **Hold** the top membrane sheet back as the cleaning and scrubbing process continues along the length of the splice so that both mating surfaces may be cleaned at approximately the same time.

**Stir Splicing Cement thoroughly** scraping sides and bottom of the can (minimum 5 minutes stirring is recommended). Properly stirred Sure-Seal EP-95 Splicing Cement will have a solid black appearance with no heavier black material remaining on the bottom or sides of the can. Membrane surfaces must be visibly dry and clean as stated previously.

D. **Apply** Splicing Cement to both mating surfaces with the 10.5 cm (4 inch) wide, 13 mm (1/2 inch) medium nap roller (provided in each carton of Splicing Cement). Apply cement smoothly, continuously and relatively even to achieve a **heavy** coat.

1. Do not allow the cement to glob or puddle.

2. When a roller cannot be effectively used (at angle changes, corners, etc.), a 13 mm (1/2 inch) thick paint brush may be used to apply Splicing Cement; however, the Splicing Cement must be applied to achieve a **smooth surface** without brush marks.

**Note:** When temperatures are expected to fall below 5° C (40° F), the use of a paintbrush must be limited (angle changes and corners) since brush marks will not bleed out.

3. One 3.78 l (1 gallon) container of Splicing Cement, applied in a **heavy**, relatively even coat, will achieve the approximate coverage rate of 23 m (75 linear feet).
F. **Allow** the cement **to dry until it is tacky** but will not string or stick to a dry finger touch and will not move when pushed with a dry finger.

G. **Do not allow the splicing cement to over-dry before mating the two surfaces** (over-dried Splicing Cement will not be tacky). If splice over-drying occurs, apply a thin freshener coat of Splicing Cement over the dried cement at half the coverage rate listed above. To avoid over-drying, Carlisle recommends using a minimum two-man installation procedure for splices longer than 3 m (10 feet).

H. Due to solvent flash off, condensation may form on freshly applied Splicing Cement when the ambient temperature is near the dew point. If condensation develops, the application of Splicing Cement must be discontinued since proper adhesion will not be achieved. Allow the surface to dry and apply a thin freshener coat of Splicing Cement as stated above to the previously coated surface when conditions allow.

I. **Just prior to closing the splice**, apply a bead of In-Seam Sealant™ approximately 3 to 6 mm (1/8 to 1/4 inch) in diameter along the center of the splice. Do not allow In-Seam Sealant to become overly dry.

   1. Approximately 23 m (75 linear feet) of coverage per tube can be achieved when a minimum 3 mm (1/8") diameter bead of In-Seam Sealant is applied.
   2. Maintain a continuous bead of In-Seam Sealant on all membrane splices including at splice intersections. Refer to appropriate detail.
   3. During splice cleaning procedures, Sure-Seal HP Splice Wipes contaminated with In-Seam Sealant cannot be reused for the application of Splice Cleaner or Primer.

J. **Roll the top membrane sheet** onto the mating surface. Take care not to stretch or wrinkle the membrane sheet to avoid a fishmouth in the field splice.

K. **Assemble** the seam with hand pressure by wiping toward the splice edge.

L. **Immediately roll the splice** with a 5 cm (2 inch) wide steel roller, using positive pressure, toward the outer edge of the splice. **DO NOT ROLL PARALLEL TO THE SPLICE EDGE.** On a completed splice, the In-Seam Sealant must remain evident and be sensitive to the touch.

M. For projects that incorporate FleeceBACK AFX membrane, overlay all field splices with 15 cm (6 inch) wide Pressure-Sensitive Flashing or 15 cm (6 inch) wide non-reinforced EPDM membrane.

N. **If the use of Pressure-Sensitive Tape is preferred for splicing in lieu of adhesive, refer to Carlisle technical publications for specific installation procedures.**

### 3.08 **MEMBRANE FLASHING**

A. At concrete pile base, break weak concrete layer of pile head to face and level.

B. Use wire brush to remove concrete residue from the steel reinforcing bars at the top of the pile and around dewatering pipes.

C. Using a high-pressure water jetting process thoroughly clean areas at pile base, top of piles, dewatering pipes and other locations using potable type clean water.

D. Where applicable, apply capillary waterproofing treatment in accordance with project specification and details.

E. At the base of the pile, adhere a 15 cm (6 inch) wide, 1 mm (.045 inch) thick reinforced EPDM membrane strip at the angle change and adhere the waterproofing membrane to the strip as well as the side of the pile. Secure the membrane on top of the pile base with Termination Bars, concrete anchors and Water Cut-Off Mastic as shown on the appropriate detail.

F. At the top of pile head, treat the top surface with two slurry coats of capillary waterproofing compound in an approximate 20 cm (8 inch) wide area. If applicable, extend the liquid applied membrane (CCW 500 or 525) over the top of the pile head.
G. Around dewatering pipes and steel reinforcing bars at top of piles and other locations where specified, tightly position water-swelling waterbar in accordance with manufacturer’s instructions.

Several options are available to terminate membrane around the top of the pile head depending upon application type and hydrostatic pressure. Carlisle may be contacted for alternate methods of termination.

3.09 FLASHING TERMINATIONS

A watertight termination shall be achieved at the top of the wall flashing above anticipated water table. The termination may consist of a 2.5 cm (1 inch) by 2.5 mm (.098 inch) thick extruded aluminum bar pre-punched 15 cm (6 inches) on center. Non-threaded, hammer driven fasteners and Water Cut-Off Mastic are used to achieve constant compression and a watertight seal directly against the concrete surface. A continuous bead of Lap Sealant shall be applied along the edge of the membrane/flashing to serve as a secondary seal.

Surface mounted reglets or other methods of termination may be utilized in lieu of compression bars. Carlisle may be consulted concerning appropriate termination details.

3.10 APPLICATION OF PROTECTION LAYER

A. A geotextile protection layer (250 g/m²) shall be installed loose-laid over the horizontal EPDM membrane and overlap adjoining sheets a minimum of 15 cm (6 inches).

B. Carlisle 3 mm (1/8 inch) thick Sure-Board shall be spot bonded to the vertical EPDM membrane using Sure-Seal Bonding Adhesive.

C. A 5 cm (2 inch) thick horizontal concrete protection screed or a vertical concrete wall shall be poured over the protection layer to complete the application. Refer to applicable detail.
Details

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PERIPHERAL WALL WATERPROOFING

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MEMBRANE SPLICES

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Schematic of Pre-Formed Waterproofing

Vertical Application - Typical Assembly

NOTE:

Level of Non-Reinforced EPDM
Reinforced EPDM membrane may be used in 1.1 or 1.5 mm (0.45 or 0.60 inch) thick

Structural Concrete Wall

3 mm (1/8") thick Carusil Sure-Board

Membrane (mechanically fastened) - see note

Permeable Protection Layer (250 g/m²)

Concrete Piles

Or Soldier Beams and Lagging
Schematic of Pre-Formed Waterproofing
Vertical Application - Optional Assembly

1. WHEN CCW 500 hot rubberized asphalt is used,
   the faceback ax membrande is required.
2. SURF-SEAL EPDM membrande can be adhered with
   bonding adhesive (PRODUCTION BOARD) or CCW 525 cold applied liquid.
3. See appropriate detail for junction between horizontal and vertical grade rubberized
   Waterproofing Membrane.

NOTES:

- Structural concrete wall
- 3 mm (1/8") thick Carlisle Sure-Board
- Sure-Seal EPDM membrane (see notes 1 and 2)
- Vertical Grade, 14 mm (0.55") average thickness
- CCW 500 (hot rubberized asphalt) or CCW 525
- Perpendicular wall (concrete piers and soldier beams and lacing)
- Capillary waterproofing treatment (or others) on steel columns and lumber; treat wall with
- Soldier beams and lacing
SURE-SEAL 1.5 mm (.060") THICK NON-REINFORCED EPDM MEMBRANE CLOSING STRIP

GEOTEXTILE PROTECTION LAYER (250 g/m²) OMIT IF MEMBRANE IS TO BE ADHERED

SURE-SEAL 1.5 mm (.060") THICK NON-REINFORCED EPDM MEMBRANE MECHANICALLY FASTENED

3 mm (1/8") THICK CARLISLE SURE-BOARD (PROTECTION BOARD) SPOT BONDED TO EPDM WITH BONDING ADHESIVE

REINFORCED CONC. SLAB & WALL

SURE-SEAL 1.5 mm (.060") THICK NON-REINFORCED EPDM MEMBRANE, LOOSE LAID

SAND/CEMENT SCREED PROTECTION

GEOTEXTILE PROTECTION LAYER (250 g/m²)

GEOTEXTILE SEPARATION LAYER (150 g/m²)

CONCRETE BLINDING

SEE DETAIL UTS-05A

SEE DETAIL UTS-05B

SEE DETAIL UTS-05C

UTS-05
PERIPHERAL WALL WATERPROOFING

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NOTES:

1. WHEN CCW 500 HOT RUBBERIZED ASPHALT IS USED, THE FleeceBACK AFX MEMBRANE IS REQUIRED.

2. SURE-SEAL EPDM MEMBRANE CAN BE ADHERED WITH BONDING ADHESIVE TO CCW 525 COLD APPLIED LIQUID WATERPROOFING MEMBRANE.

SURE-SEAL 1.5 mm (.060") THICK REINF. EPDM SECUREMENT STRIP (RUSS)
SURE-SEAL 1.5 mm (.060") THICK UNCURLED ELASTOFORM FLASHING
SURE-SEAL 90-8-30A BONDING ADHESIVE (REQUIRED AT BASE OF WALL)

REINFORCED CONC. SLAB & WALL
SURE-SEAL FleeceBACK (NON-REINFORCED FLEECE BACKED) EPDM MEMBRANE (OR SURE-SEAL EPDM MEMBRANE), LOOSE LAID
SAND/CEMENT SCREED PROTECTION
GEOTEXTILE PROTECTION LAYER (250 g/m²)
CCW 525 FLUID-APPLIED SEAMLESS RUBBER WATER-PROOFING MEMBRANE, 1.4 mm (.055") THICK HORIZONTAL SELF-LEVELING GRADE

PERIPHERAL WALL
SEE DETAIL UTS-06B
SEE DETAIL UTS-06C
SEE DETAIL UTS-06A

3 mm (1/8") THICK CARLISLE SURE-BOARD (PROTECTION BOARD) SPOT BONDED VERTICALLY TO EPDM WITH BONDING ADHESIVE

FOAM BACKING ROD

UTS-06
PERIPHERAL WALL WATERPROOFING
Membrane Splice with Splicing Cement

1. Membrane splice procedure is for splices between cured EPDM sections.

2. Apply splicing cement over entire 150 mm (6") wide minimum splice area prior to membrane splice.

3. In-seam sealant shall be continuous along the length of the splice.

Application of in-seam sealant:

- Apply in-seam sealant continuous at all splice intersections.
- Apply in-seam sealant continuous in-seam sealant.

Notes:

- 75 mm (3")
- 150 mm (6")
- 75 mm (3")
- Min.
- Min.
- Min.
3. IN-SEAM SEALANT SHALL BE CONTINUOUS ALONG THE LENGTH OF THE SPlice.

2. APPLY SPlicing CEMENT OVER ENTIRE 150 MM (6") MINIMUM OVERLAY SPlice AREA PRIOR TO APPLICATION OF IN-SEAM SEALANT.

1. MEMBRANE SPlice PROCEDURE IS FOR SPlices BETWEEN CURVED EPDM SECTIONS AT DE-WATERED INSTALLATION STEPS WITH A HIGH WATER TABLE ABOVE THE LEVEL OF THE MEMBRANE.

NOTES:
Section II
WATER CONTAINMENT SYSTEM
# Sure-Seal® EPDM and Geomembrane™ Water Containment and Lining System

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April 2003

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This specification outlines Carlisle's Sure-Seal and Geomembrane Water Containment and Lining System requirements and is intended for use as a guideline by developers, engineers and other design professionals when specifying a lining material for water containment or tanks. While the specification contains specific installation details pertaining to various methods of membrane termination, contractors may reference other Carlisle technical publications for in-depth application procedures.

PART I  GENERAL

1.01 DESCRIPTION

This Sure-Seal EPDM and Geomembrane Water Containment System utilize the Sure-Seal EPDM membrane or the Geomembrane as liners for reservoirs, ponds, canals and other irrigation and water management systems. Both membranes (depending on type and thickness) can also be utilized for floating covers associated with such water containment systems. In this specification, the use of the Geomembrane has been extended into lining of structural concrete tanks. Confinement and lack of ventilation that is generally associated with tank waterproofing and lining applications, make the use of the EPDM impracticable due to possible fume accumulation resulting from adhesives flash off.

CAUTION:  This Water Containment and Lining System shall not be utilized for containment of hazardous waste (poisonous, toxic, corrosive, flammable, etc.).

A. Water Containment Systems (Reservoirs, Ponds, Canals and Irrigation Systems)

1. The Sure-Seal Water Containment System incorporates 1.1 mm (.045 inch) or 1.5 mm (.060 inch) thick Sure-Seal, black, non-reinforced or reinforced EPDM membrane loose-laid directly over compacted soil or over a geotextile separator sheet (339 g/m² -10 oz/square yard) placed over structural concrete or mud slabs. Adjoining sheets of EPDM membrane are spliced together using Splicing Cement, In-Seam Sealant™ and Lap Sealant or SecurTAPE™/Primer. All membrane splices shall be a minimum of 150 mm (6 inches) wide.

Notes: For reservoirs with side slopes exceeding 30 degrees or those with floating covers, a reinforced 1.1 mm (.045 inch) or 1.5 mm (.060 inch) thick EPDM membrane shall be used.

The Sure-Seal EPDM Water Containment Lining Systems is not intended for use as a liner for fishponds. Contact Carlisle for special membranes available.

2. The Geomembrane Water Containment System incorporates .8 mm (.036”), 1.1 mm (.045”) or 1.5 mm (.060 inch) thick scrim-reinforced, white, tan or black, Thermoplastic Polypropylene geomembrane loose-laid directly over compacted soil or over a geotextile separator sheet when installed over structural concrete. Adjoining sheets of Geomembrane membrane are overlapped and joined together with a minimum 40 mm (1-1/2 inch) wide hot air weld or 80 mm (3 inches) double weld.
B. Tank Lining System

The Geomembrane Tank Lining System incorporates 1.1 mm (.045") or 1.5 mm (.060 inch) thick scrim-reinforced, white, tan or black, Thermoplastic Polypropylene Geomembrane installed loose-laid on the horizontal plane and mechanically fastened on the sides of the tank. On the horizontal plane over smooth surface structural concrete, the geomembrane 3.7 m (12 foot) wide is loose-laid over a 339 g/m² (10 oz/square yard) geotextile separator sheet. On the sides of the tank, 1.2 m (4 foot) or 1.8 m (6 foot) wide section of membrane is mechanically fastened with the Sure-Seal Termination Bar and Nail-In Fasteners to the smooth structural concrete wall. Adjoining sheets of Geomembrane membrane are overlapped and joined together with a minimum 40 mm (1-1/2 inch) wide single hot air weld or 80 mm (3 inches) double weld.

C. Construction details pertaining to the installation of this system have been designated as follows:

1. EPDM and Geomembrane Water Containment System designated with “L” for lining of systems ponds, canals, reservoirs, etc. Tanks are excluded.

2. Geomembrane Tank Lining System designated with “TL” for lining of structural concrete tanks.

1.02 QUALITY ASSURANCE

The Sure-Seal EPDM and Geomembrane Water Containment and Lining System is recommended for use in reservoirs, decorative ponds, storage tanks, fire protection and water storage system, irrigation canals, etc.

CAUTION: This Water Containment and Lining System shall not be utilized for containment of hazardous waste (poisonous, toxic, corrosive, flammable, etc.).


<table>
<thead>
<tr>
<th>Property</th>
<th>Reference</th>
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</thead>
<tbody>
<tr>
<td>Tensile Strength</td>
<td>ASTM D412, Die C</td>
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<tr>
<td>Elongation, Ultimate</td>
<td>ASTM D412, Die C</td>
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<tr>
<td>Tensile Set</td>
<td>ASTM D412, Method A, Die C, % Elongation</td>
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<tr>
<td>Tear Resistance</td>
<td>ASTM D624, Die C</td>
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<tr>
<td>Brittleness Temperature</td>
<td>ASTM D746</td>
</tr>
<tr>
<td>Linear Dimensional Change</td>
<td>ASTM D1204, 166 h @ 240º F ± 4º F</td>
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<tr>
<td>Water Absorption</td>
<td>ASTM D471, @ 70º C ± 2º C (158º F ± 4º F) for 166 h</td>
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<tr>
<td>Factory Seam Strength</td>
<td>ASTM D816, Modified Method B, 1” wide, 2”/min.</td>
</tr>
<tr>
<td>Water Vapor Permeance</td>
<td>ASTM E96, Procedure B W relative humidity of 45% @ 70º F ± 4º F</td>
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<tr>
<td>Hardness Durometer A</td>
<td>ASTM D2240</td>
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<tr>
<td>Resistance to Soil Burial</td>
<td>ASTM D3083</td>
</tr>
<tr>
<td>Resistance to Heat Aging</td>
<td>ASTM D573, Properties after 166 h @ 240º F ± 4º F</td>
</tr>
<tr>
<td>Test Resistance to Puncture</td>
<td>ASTM E154</td>
</tr>
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</table>

B. The Sure-Seal EPDM membrane meets the Institut Pasteur de Lille test Afnor XP-P 41250-1 approval as a liner in potable water systems (Reference: MAT 97-003 – July 97).

C. The Geomembrane is available in two grades; potable water or industrial grade. The potable grade (available in black only) was tested by NSF (National Sanitation Foundation) International and meets the requirements of ANSI/NSF Standard 61 for Drinking Water System Components Health Effects.

D. This Sure-Seal EPDM and Geomembrane Water Containment and Lining System must be installed by an Authorized Applicator and in compliance with Carlisle’s installation details and project specification as approved by Carlisle. Deviations from Carlisle's details or approved specification shall be secured in writing prior to commencement of work.

E. Comply with applicable regulatory requirements and applicable codes, ordinances, regulations and laws.
F. On-site technical assistance is available for a charge. Projects where technical assistance is required must have a manufacturer’s approved drawing.

1.03 SUBMITTALS

A. To ensure compliance with the applicable design criteria, project drawings, specification and pertinent details may be submitted for Carlisle’s review.

B. Requests for certification and/or formal drawing approval must be accompanied by a copy of the project specification and details. Shop drawings of maximum size 43 cm x 56 cm (17” x 22”) are preferred.

C. Substitution of a non-Carlisle supplied product is permitted upon review and approval. Samples of the product along with technical literature may be forwarded to Carlisle for consideration.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver materials to the job site in the original, unopened containers labeled with the manufacturer's name, brand name and installation instructions.

B. Job site storage temperatures in excess of 32°C (90°F) may affect shelf life of curable materials (i.e., sealants and cleaners).

C. When sealants or cleaners are exposed to lower temperatures, restore to minimum 16°C (60°F) before use.

D. Store Geomembrane in the original undisturbed plastic wrap in a cool, shaded area and cover with light-colored, breathable tarpaulins. Geomembrane that has been exposed to the elements for approximately 7 days must be prepared with Weathered Membrane Cleaner prior to hot air welding.

1.05 JOB CONDITIONS

A. The Geomembrane and Sure-Seal EPDM membranes resist a wide variety of chemicals. Depending upon level of concentration and temperature, the membrane performance will vary. Carlisle may be contacted to determine of compatibility of either membrane with a specific chemical.

B. Comply with applicable codes and regulations pertaining to the operation and storage of heavy equipment.

C. Coordination between various trades is essential to avoid unnecessary traffic over sections of already installed membrane to prevent damage to the membrane.

D. Do not allow waste products (i.e., petroleum, grease, oil, solvents, vegetable or mineral oil, animal fat) or direct steam venting to come in contact with the membrane.

E. Do not expose Geomembrane and accessories to constant temperatures in excess of 49°C (120°F). Do not expose EPDM membrane and accessories to constant temperatures in excess of 82°C (180°F).

F. Prior to the use of any product, consult the Material Safety Data Sheet and Technical Data Bulletin for cautions and warnings. Store adhesives, sealants and cleaners away from all sources of heat, flame or sparks. Do not use in confined or unventilated areas.

G. Cold temperatures will not restrict installation of the Sure-Seal EPDM and Geomembrane Water Containment and Lining System. Follow specified precautions for storage of materials.

H. Splicing surfaces should be dry and clean.
I. Substrate shall be free of ponded water, ice or snow.
J. Coordinate work with other trades.
K. Maintain work area neat and orderly condition, removing empty containers, rags and debris daily from the site.

1.06 WARRANTY

A Material Warranty is available for a charge. The warranty covers normal deterioration due to weathering and is pro-rated. Contact Carlisle for warranty samples and applicable terms.

PART II PRODUCTS

2.01 GENERAL

The components of this EPDM and Geomembrane Water Containment and Lining System are to be products of Carlisle or accepted by Carlisle as compatible. The installation, performance or integrity of products by others, when selected by the specifier and accepted as compatible by Carlisle, is not the responsibility of Carlisle.

2.02 MEMBRANE

A. Sure-Seal (black) 1.1 mm (.045”) and 1.5 mm (.060”) thick non-reinforced EPDM (Ethylene, Propylene, Diene Terpolymer) membrane; maximum 15 m (50’) wide, maximum 30 m (100’) long which meets ASTM D6134-97. Used for lining of water containment systems (i.e., reservoirs, ponds, canals, irrigation trenches, etc.). Not for use for fishponds, floating covers and ponds with side slopes greater than 30°.

<table>
<thead>
<tr>
<th>Physical Property</th>
<th>Test Method</th>
<th>SPEC.(Pass)</th>
<th>Typical</th>
<th>.045” Standard</th>
<th>.060” FR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tolerance on Nominal Thickness, %</td>
<td>ASTM D 412</td>
<td>±10</td>
<td>±10</td>
<td>±10</td>
<td></td>
</tr>
<tr>
<td>Tensile Strength, min, psi (MPa)</td>
<td>ASTM D 412</td>
<td>1305 (9)</td>
<td>1630 (11.2)</td>
<td>1630 (11.2)</td>
<td></td>
</tr>
<tr>
<td>Elongation, Ultimate, min. %</td>
<td>ASTM D 412</td>
<td>350</td>
<td>520</td>
<td>520</td>
<td></td>
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<tr>
<td>Tear Resistance, min, lbf/in (kN/m)</td>
<td>ASTM D 624 (Die C)</td>
<td>175 (30.6)</td>
<td>230 (40.3)</td>
<td>230 (40.3)</td>
<td></td>
</tr>
<tr>
<td>Factory Seam Strength, min.</td>
<td>Modified ASTM D 816</td>
<td>Membrane Rupture</td>
<td>Membrane Rupture</td>
<td>Membrane Rupture</td>
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<tr>
<td>Resistance to Heat Aging*</td>
<td>ASTM D 573</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Properties after 4 weeks @ 240°F (116°C)</td>
<td>ASTM D 412</td>
<td>1205 (8.3)</td>
<td>1500 (10.3)</td>
<td>1500 (10.3)</td>
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<tr>
<td>Tensile Strength, min, psi (MPa)</td>
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<td>225</td>
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<tr>
<td>Elongation, Ultimate, min. %</td>
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<td>215 (37.6)</td>
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<td>Tear Resistance, min, lbf/in (kN/m)</td>
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<td>±1.0</td>
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<td>ASTM D 1204</td>
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<tr>
<td>Ozone Resistance*</td>
<td>ASTM D 1149</td>
<td>No Cracks</td>
<td>No Cracks</td>
<td>No Cracks</td>
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<tr>
<td>Condition after exposure to 100 pphm</td>
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<tr>
<td>Ozone in air for 168 hours @ 104°F (40°C)</td>
<td>Specimen is at 50% strain</td>
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<tr>
<td>Brittleness Temp., max. deg. F (deg. C)*</td>
<td>ASTM D 746</td>
<td>-75 (-59)</td>
<td>-85 (-65)</td>
<td>-85 (-65)</td>
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<td>Resistance to Water Absorption*</td>
<td>ASTM D 471</td>
<td>+4.0</td>
<td>+2.0</td>
<td>+2.0</td>
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<tr>
<td>After 7 days immersion @ 158°F (70°C)</td>
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<td>Change in mass, max. %</td>
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<td>Water Vapor Permeance* max, perm</td>
<td>ASTM E 96 (Proc. B or BW)</td>
<td>0.1</td>
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<tr>
<td>Resistance to Outdoor (Ultraviolet) Weathering*</td>
<td>ASTM G-26</td>
<td>No Cracks</td>
<td>No Crazing</td>
<td>No Crazing</td>
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<tr>
<td>Xenon-Arc, 7560 kJ/m² total radiant exposure at .70 W/m² irradiance, 176°F (80°C) black panel temp.</td>
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<td>No Crazing</td>
<td>No Crazing</td>
<td>No Crazing</td>
<td></td>
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</table>

* Not a Quality Control Test due to the time required for the test or the complexity of the test. However, all tests are run on a statistical basis to ensure overall long-term performance of the sheeting.
B. Sure-Seal (black) 1.1 mm (.045”) and 1.5 mm (.060”) thick reinforced EPDM (Ethylene, Propylene, Diene Terpolymer) membrane; maximum 3.3 m (10’) wide, maximum 30 m (100’) long which meets ASTM D6134-97. The reinforced with polyester fabric which meets ASTM D4637 and ANSI/RMA IPR-2.

Used for lining of water containment systems (i.e., reservoirs, ponds, canals, irrigation trenches, including ponds with side slopes greater than 30°, as well as floating covers.). The use of this Sure-Seal EPDM membrane is not intended for lining of fishponds.

<table>
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<th>Physical Property</th>
<th>Test Method</th>
<th>SPEC.(Pass)</th>
<th>Typical</th>
</tr>
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<td>ASTM D 751</td>
<td>±10</td>
<td>±10</td>
</tr>
<tr>
<td>Thickness Over Scrim, min, in. (mm)</td>
<td>ASTM D 4637</td>
<td>.015 (.381)</td>
<td>.045”-.016 (.406)</td>
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<tr>
<td></td>
<td>Annex</td>
<td>.060”-.020 (.508)</td>
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<tr>
<td>Breaking Strength, min, lbf (N)</td>
<td>ASTM D 751</td>
<td>90 (400)</td>
<td>180 (800)</td>
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<tr>
<td></td>
<td>Grab Method</td>
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<tr>
<td>Elongation, Ultimate, min, %</td>
<td>ASTM D 751</td>
<td>250 **</td>
<td>500 **</td>
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<tr>
<td></td>
<td>Grab Method</td>
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<tr>
<td>Tear Strength, min, lbf(N)</td>
<td>ASTM D 751</td>
<td>10 (45)</td>
<td>30 (132)</td>
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<tr>
<td></td>
<td>B Tongue Tear</td>
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<tr>
<td>Brittleness Temp., max, deg. F (deg. C) *</td>
<td>ASTM D 2137</td>
<td>-49 (-45)</td>
<td>-75 (-59)</td>
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<tr>
<td>Resistance to Heat Aging *</td>
<td>ASTM D 573</td>
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<td></td>
</tr>
<tr>
<td>Properties after 4 weeks @ 240°F</td>
<td>ASTM D 751</td>
<td>80 (355)</td>
<td>175 (780)</td>
</tr>
<tr>
<td>Breaking Strength, min, lbf (N)</td>
<td>ASTM D 751</td>
<td>200 **</td>
<td>250 **</td>
</tr>
<tr>
<td>Elongation, Ultimate, min, %</td>
<td>ASTM D 1204</td>
<td>±1.0</td>
<td>-0.7</td>
</tr>
<tr>
<td>Linear Dimensional Change, max, %</td>
<td>ASTM D 1149</td>
<td>No Cracks</td>
<td>No Cracks</td>
</tr>
<tr>
<td>Ozone Resistance*</td>
<td>ASTM D 471</td>
<td>+4.0 **</td>
<td>+2.0 **</td>
</tr>
<tr>
<td>Condition after exposure to 100 pphm</td>
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<tr>
<td>Ozone in air for 168 hours @ 104° F</td>
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<tr>
<td>Specimen wrapped around 3” mandrel</td>
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<tr>
<td>Resistance to Water Absorption*</td>
<td>ASTM G-26</td>
<td>No Cracks</td>
<td>No Cracks</td>
</tr>
<tr>
<td>After 7 days immersion @ 158°F (70°C)</td>
<td></td>
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<td></td>
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<td>+2.0 **</td>
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<tr>
<td>Resistance to Outdoor (Ultraviolet) Weathering*</td>
<td></td>
<td>No Cracks</td>
<td>No Crazing</td>
</tr>
</tbody>
</table>

* Not a Quality Control Test due to the time required for the test or the complexity of the test. However, all tests are run on a statistical basis to ensure overall long-term performance of the sheeting.

** Specimens to be prepared from coating rubber compound, vulcanized in a similar method to the reinforced product.
C. **Geomembrane** - A reinforced 0.8 mm (.036 inch), 1.1 mm (.045 inch), 1.5 mm (.060 inch) thick Thermoplastic Polypropylene geomembrane conforming to the following physical properties. Membrane sheets for 0.8 and 1.1 mm thick are available in rolls 3.7 m (12 feet) wide and 189 m (600 feet) long and for 1.5 mm thick 3.7 m (12 feet) wide and 122 m (400 feet) long. Geomembrane is available in black, tan or white. Used for buried or exposed Geomembrane applications.

1. 1.1 or 1.5 mm thick membrane are required for lining of tanks (vertical or horizontal applications) and for use as floating covers for ponds reservoirs or canals.

2. For potable water applications, black geomembrane meeting ANSI/NSF Standard 61 must be used.

### Reinforced Geomembrane

<table>
<thead>
<tr>
<th>Physical Property</th>
<th>Test Method</th>
<th>Property Of Unaged Sheet</th>
<th>Property After Aging(^1) 28 days @ 158 °F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tolerance on nominal thickness, %</td>
<td>ASTM D 751</td>
<td>± 10</td>
<td>400 (2.8) typical - .036 450 (3.1) typical - .045 500 (3.4) typical - .060</td>
</tr>
<tr>
<td>Thickness over scrim, in. (mm)</td>
<td>ASTM D 4637</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hydrostatic resistance, lbf (kN) (Mullen burst)</td>
<td>ASTM D 751 Procedure A</td>
<td>350 (2.4) min. 400 (2.8) typical - .036 450 (3.1) typical - .045 500 (3.4) typical - .060</td>
<td>350 (2.4) min. 400 (2.8) typical - .036 450 (3.1) typical - .045 500 (3.4) typical - .060</td>
</tr>
<tr>
<td>Breaking strength, lbf (kN)</td>
<td>ASTM D 751 Grab Method</td>
<td>250 (1.1) min. 300 (1.3) typical</td>
<td>250 (1.1) min. 300 (1.3) typical</td>
</tr>
<tr>
<td>Elongation at break of fabric, %</td>
<td>ASTM D 751</td>
<td>25 typical</td>
<td>25 typical</td>
</tr>
<tr>
<td>Tearing strength, lbf (N)</td>
<td>ASTM D 5884 Tongue Tear</td>
<td>55 (245) min. 100 (445) typical</td>
<td>55 (245) min. 100 (445) typical</td>
</tr>
<tr>
<td>Low temperature flexibility, °F (°C)</td>
<td>ASTM D 2136 1/8 in. mandrel 4 hour @ temp.</td>
<td>-40 (-40) max. -50 (-46) typical</td>
<td>-40 (-40) max. -50 (-46) typical</td>
</tr>
<tr>
<td>Linear Dimensional Change (shrinkage), %</td>
<td>ASTM D 1204</td>
<td>+/- 1.0 max. - 0.5 typical</td>
<td></td>
</tr>
<tr>
<td>Ozone resistance, 100 pphm, 168 hours</td>
<td>ASTM D 1149</td>
<td>No cracks</td>
<td>No cracks</td>
</tr>
<tr>
<td>Resistance to water (distilled) absorption After 30 days immersion 122 °F (50 °C) Change in mass, %</td>
<td>ASTM D 471 (coating compound)</td>
<td>1.0 max. 0.5 typical</td>
<td></td>
</tr>
<tr>
<td>Field seam strength, lbf/in. (kN/m) Seam tested in peel</td>
<td>ASTM D 1876</td>
<td>40 (7.0) min. 60 (10.5) typical</td>
<td></td>
</tr>
<tr>
<td>Water vapor permeance, Perms</td>
<td>ASTM E 96</td>
<td>0.10 max. 0.05 typical</td>
<td></td>
</tr>
<tr>
<td>Puncture resistance, lbf (N)</td>
<td>FTM 101C Method 2031</td>
<td>250 (1110) min. 300 (1330) typical 350 (1560) typical</td>
<td>250 (1110) min. 300 (1330) typical 350 (1560) typical</td>
</tr>
<tr>
<td>Resistance to xenon-arc weathering (^1) Xenon-Arc, 10,080 kJ/m² total radiant exposure, visual condition at 10X</td>
<td>ASTM G 155 0.70 W/m² 80° C B.P.T.</td>
<td>No cracks No loss of breaking or tearing strength</td>
<td></td>
</tr>
</tbody>
</table>

\(^1\) Approximately equivalent to 8,000 hours exposure at 0.35 W/m² irradiance

2.03 **FLASHING**

A. **Sure-Seal Pressure-Sensitive Uncured Flashing**: A nominal 1 mm (40 mil) black, uncured EPDM membrane laminated to a nominal 30 mil cured, pre-applied adhesive tape. Available in 23 cm (9 inch) widths and 15.3 m
(50 feet) long rolls used to flash inlet or outlet pipes, overflow drains in conjunction with EPDM water containment systems. Also used to provide a compression seal with stainless steel compression bars in Geomembrane tank lining applications.

B. **Sure-Seal Uncured EPDM Elastoform Flashing**: an easily formed, 1.5 mm (.060") thick uncured EPDM membrane available in widths of 15, 23, 30, 50, and 60 cm (6, 9, 12, 18 and 24 inches) and lengths of 30 m (100 feet). Used for flashing of inlet/outlet pipes and overflow drains.

C. **GeoFlash** – 1 mm (.040 inch) or 3 mm (.120 inch) thick non-reinforced flashing available in white, tan and black in rolls 6’ x 50’ (1.8 m x 15 m). The 1 mm thick flashing is used to overlay hot air welded seams and the 3 mm thick flashing is used to terminate around inlet/outlet pipes, overflow drains and to form inside/outside corners in tank lining applications.

### 2.04 CLEANERS PRIMERS, ADHESIVES AND SEALANTS

A. **Weathered Membrane Cleaner**: Used to prepare Geomembrane or Sure-Seal EPDM membranes that have been exposed to the elements for approximately 7 days to remove surface oxidation and general construction dirt prior to hot air welding of the Geomembrane or prior to primer application and splicing of the Sure-Seal EPDM membrane. The Weathered Membrane Cleaner is applied at an approximate coverage rate of 37 m² (400 square feet) per gallon (one surface).

**Note:** If the Weathered Membrane Cleaner is used in conjunction with the Sure-Seal EPDM membrane, Sure-Seal Splice Cleaner is not required prior to application of Splicing Cement. When SecurTAPE is used for splicing, HP-250 Primer must be applied after cleaning the membrane with the Weathered Membrane Cleaner.

B. **Welding Rod**: 5 mm (3/16 inch) diameter polypropylene rod, available in white, tan and black, used in conjunction with a extrusion welder to seal exposed scrim along cut edges of Geomembrane, intersections between hot air welded seams and all flashing details. One 5.4 kg (12 pound) spool per box contains approximately 305 m (1000 feet) of welding rod.

C. **Water Cut-Off Mastic**: For use with Sure-Seal EPDM membrane to prevent moisture migration at compression drains and beneath metal termination bars. Applied at a coverage rate of approximately 3 m (10 feet) per tube or 30 m (100 feet) per 3.78 liters (1 gallon).

D. **90-8-30 A Bonding Adhesive**: A high-strength, yellow colored, synthetic rubber adhesive used for bonding Sure-Seal EPDM membrane to various surfaces. Applied at a coverage rate of approximately 5.6 square meters (60 square feet) per 3.78 liters (1 gallon) per finished surface (includes coverage on both surfaces).

E. **Sure-Weld Bonding Adhesive**: A high-strength, synthetic rubber adhesive used for bonding Geomembrane to various surfaces. The adhesive is applied to both the membrane and the substrate at a coverage rate of approximately 5.6 square meters (60 square feet) per 3.78 liters (1 gallon) per finished surface (includes coverage on both surfaces).

F. **Sure-Seal Splice Cleaner**: A solvent-based cleaner used in conjunction with Sure-Seal EPDM membrane to remove dust, dirt or other contaminants prior to applying Splicing Cement and Lap Sealant.

G. **Splicing Cement**: A high-strength, butyl based contact cement that is used in conjunction with Sure-Seal EPDM membrane for splicing adjoining membranes or flashings.

H. **In-Seam Sealant**: A one-part, gun consistency sealant applied in adhesive splices between cured Sure-Seal EPDM membrane sections.
I. **Sure-Seal Lap Sealant**: A heavy-bodied material (trowel or gun-consistency) used to seal the exposed edges of a Sure-Seal EPDM membrane splice. A pre-formed Lap Sealant tool is included in each carton of Lap Sealant.

J. **PT 304 Sealant**: A single-component, moisture-curing, gun-grade, multi-purpose construction sealant used to seal above termination bars at a coverage rate of approximately 3 m (10 feet) per tube or 30 m (100 feet) per gallon.

K. **Sure-Seal SecurTAPE™**: A 15 cm (6 inch) wide by 30 m (100 feet) long splice tape used for splicing adjoining sections of Sure-Seal EPDM membrane. The tape is also available in 7.5 cm (3 inches) wide by 30 m (100 feet) long for use in conjunction with Geomembrane as terminations around pipes and overflow drains.

L. **Sure-Seal HP-250 Primer**: A solvent-based primer used to prepare the surface of Sure-Seal EPDM membrane for application of Splice Tape. This Primer can also be used in conjunction with EP-95 Splicing Cement in lieu of Splice Cleaner and in tank lining applications to prime concrete surfaces to which a compression termination utilizing Pressure-Sensitive Flashing is utilized.

### 2.05 FASTENING COMPONENTS

A. **Sure-Seal Termination Bar**: A 25 mm (1 inch) wide and 3 mm (1/8 inch) thick extruded aluminum bar pre-punched 150 mm (6 inches) on center used for securement of geomembrane on vertical surfaces of structural concrete tanks.

B. **Termination Bar Nail-In Fastener**: A 3.2 cm (1-1/4 inch) long expansion anchor with threaded drive pin used for fastening Sure-Seal Termination Bar to concrete walls. The fastener is set by hammering the drive pin into place; removal can be accomplished by unscrewing the pin using a screw driver or drill.

C. **HP CD-10 Concrete Spike**: A hammer-driven, non-threaded, black epoxy electro-deposition coated (E-Coat) fastener for use with structural concrete rated 211 kg/cm² (3,000 psi) or greater.

D. **HD 14-10 Concrete Fastener**: A #14 threaded fastener used for minimum 211 kg/cm² (3,000 psi) structural concrete.

### 2.06 OTHER PRODUCTS

A. **Stainless Steel Termination Bar (by others)**: A 50 mm (2 inch) wide and 6 mm (1/4 inch) thick bar pre-punched 150 mm (6 inches) on center to be used in conjunction with stainless steel fasteners as a membrane termination against structural concrete surfaces in tanks or around edges of ponds.

B. **Protection Fabric**: A non-woven 339 g/m² (10 oz/square yard), polypropylene, geotextile fabric that is used as a protection layer to separate between a loose-laid membrane and the structural concrete substrate.

<table>
<thead>
<tr>
<th>Property</th>
<th>Test Method</th>
<th>Protection Fabric</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit Weight</td>
<td>ASTM D 5261</td>
<td>339 g/m²</td>
</tr>
<tr>
<td>Grab Tensile Strength</td>
<td>ASTM D 4632</td>
<td>1.11 kN</td>
</tr>
<tr>
<td>Grab Tensile Elongation</td>
<td>ASTM D 4632</td>
<td>50%</td>
</tr>
<tr>
<td>Mullen Burst</td>
<td>ASTM D 3786</td>
<td>3584 kPa</td>
</tr>
<tr>
<td>Puncture</td>
<td>ASTM D 4833</td>
<td>0.730 kN</td>
</tr>
<tr>
<td>Trapezoid Tear</td>
<td>ASTM D 4533</td>
<td>0.445 kN</td>
</tr>
<tr>
<td>UV Resistance²</td>
<td>ASTM D 4355</td>
<td>70% @ 500 hrs.</td>
</tr>
<tr>
<td>Roll Width</td>
<td>-</td>
<td>4.57 m</td>
</tr>
<tr>
<td>Roll Length</td>
<td>-</td>
<td>54.8 or 182.8 m</td>
</tr>
</tbody>
</table>
2.07 RELATED EQUIPMENT

A. Generator/Electrical Requirements (for application of Geomembrane)

Power supplies do not typically provide the proper amount of power necessary for consistent hot air welding. The use of a portable generator conforming to the following guidelines is strongly advised.

1. **A minimum 6500 watt generator** with a minimum output of 210 volts is required **for one Automatic Hot Air Welding Machine**. Reduced power availability will result if additional equipment is connected to the generator and may result in faulty hot air welded seams. GFI (Ground Fault Interrupter) protection is recommended. Additional generators will be required for operating other power tools and hand held hot air welders.

   **Electrical cords** (3 conductor) of the maximum length indicated must be used with the corresponding wire as listed below:

<table>
<thead>
<tr>
<th>Maximum Length</th>
<th>Wire Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 m (50 foot)</td>
<td>#12</td>
</tr>
<tr>
<td>30m (100 foot)</td>
<td>#10</td>
</tr>
<tr>
<td>90 m (300 foot)</td>
<td>#8</td>
</tr>
</tbody>
</table>

2. **A minimum 3,000 watt generator** may be used to power a maximum of **two hand held welders** as long as no other equipment is connected. This generator should service a minimum of 110 volts and be GFI (Ground Fault Interrupter) protected.

   **Electrical cords** (3 conductor) of the maximum length indicated must be used with the corresponding wire as listed below:

<table>
<thead>
<tr>
<th>Maximum Length</th>
<th>Wire Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 m (50 foot)</td>
<td>#14</td>
</tr>
<tr>
<td>30m (100 foot)</td>
<td>#12</td>
</tr>
</tbody>
</table>

   For extension cords longer than 30 m (100 feet), consult an electrician or electrical contractor to ensure proper size of generator and wire.

B. **Automatic Hot Air Welding Machine**:

   An electrically powered, self-propelled device that utilizes an electrical resistance heating element or heater and fan-forced super heated air to weld Geomembrane seams.

   1. **Welding speed**: The speed of the welding machine must be no faster than necessary to produce a good hot air weld, and will vary according to environmental conditions.

   2. **Temperature recommendations**: Operating temperature is approximately 538°F (1000°F) at a #8 temperature setting. Geomembrane will not “bleed out” (membrane begins to flow out from edge).

C. **Hot Air Hand Welder**:

   1. An electrically powered, hand-held device that utilizes an electrical resistance heating element or heater and fan-forced super heated air to hot air weld Geomembrane and flashing. A hand-held silicone rubber roller is used in conjunction with the welder to apply the pressure that fuses the heated membrane surfaces to each other.

   2. The hand-held welder is typically used to repair seams, or when the use of the automatic hot air welding machine is inappropriate (such as flashing penetrations and on vertical surfaces).
D. **Extrusion Welder** – Driven by an electric motor, a 5 mm (3/16 inch) diameter, polypropylene welding rod is fed into the extruder barrel via a rod feed block. The welding rod passes through a heated barrel and is converted to a molten state before exiting the extruder nozzle. The molten is deposited on the preheated membrane surface and into a welding shoe. The welding rods are used to seal exposed scrim along cut edges of Geomembrane, intersections between hot air welded seams and all flashing details.

E. **Seam Prober**: Probing of hot air welded seam is essential to ensure the continuous watertight seal at “T” joints and intersections between hot air welded seams and pipe penetrations. The use of a cotter pin puller is the recommended tool.

F. **Silicone Rubber Roller**: A 40 mm (1-1/2 inch) wide rubber roller used for rolling hot air hand welded membrane seams and flashing.

**PART III EXECUTION**

3.01 **GENERAL**

A. Refer to the applicable Material Safety Data Sheets and Technical Data Bulletins for cautions and warnings.

B. Comply with the manufacturer’s published instructions for the installation of the Sure-Seal EPDM and Geomembrane Water Containment and Lining System including proper substrate preparation, jobsite considerations and weather restrictions.

3.02 **SUBSTRATE PREPARATION**

A. **Earth-Dug Reservoirs**

1. Excavate to the designated water depth in addition to a minimum of 60 cm (2 feet) of free board (distance between the top of the reservoir and the anticipated water level typically determined by the designer) to prevent possible water overflow.

2. During excavation, boulders, cobbles and gravel shall be removed. A relatively smooth substrate shall be achieved by compacting a mixture of medium (.4 to 2 mm) and coarse (2 to 5 mm) sand (mixture 65% to 35% respectively). Finer grades of sand, silt or clay can be used if available. Compact mixture to 95% Modified Proctor in accordance with ASTM D 1557.

3. Soil condition should be evaluated and slopes shall be provided in the base to preclude gas entrapment. If necessary, a relief mechanism through or beneath the liner shall be incorporated by the designer.

4. Surrounding the earth dug reservoir, excavate a continuous trench 30 cm x 30 cm (12” x 12”) minimum approximately 60 cm (2 feet) from the top edge of the reservoir.

B. **Structural Concrete Tanks or Reservoirs**

1. For structural concrete tanks or reservoir, new structural concrete shall be relatively even and water cured, with a smooth broom finish and in place for a minimum of 72 hours.

2. Sweep all loose debris from the structural concrete substrate prior to application of the membrane.

3. Remove splatters, fins, ridges or other projections to provide a level vertical or horizontal surface. Fill holes, honeycombs, rock pockets, spalls or other voids and indentations with approved concrete patching compound.
4. Grind or fill surface at cold joints where each concrete pour is at a different plane to provide a smooth and level surface.

5. All surfaces shall be structurally sound, dry and free of dust, dirt and frost.

3.03 GEOMEMBRANE APPLICATION (For Tank Lining, Reservoirs, Ponds, Canals and Floating Covers, etc.)

Only 1.1 or 1.5 mm thick Geomembrane may be used for lining of structural concrete tanks and as floating covers for ponds, reservoirs or canals. Applications where the Geomembrane is used in conjunction with potable water, black geomembrane (potable grade) meeting ANSI/NSF Standard 61 must be used.

A protective layer of geotextile fabric 339 g/m² (10 oz/square yard) is required as a separator when installing the Geomembrane over structural concrete.

A. Tank Lining

To avoid possible damage of the Geomembrane on horizontal surfaces, begin the installation on the vertical surfaces, starting from the top of the wall working toward the bottom. Periodically, remove construction debris, dust, fins and concrete particulate resulting from fastening membrane on the vertical walls.

1. Cut the Geomembrane into 1.2 m (4 foot) or 1.8 m (6 foot) widths and fasten horizontally using Sure-Seal Termination Bars and Termination Bar Nail-In, Carlisle CD-10 Concrete Spike or HD 14-10 Threaded Concrete Fasteners 30 cm (12 inches) on center.

   If pre-drilling of the structural concrete is to be avoided, Carlisle HD14-10 Threaded Fasteners or pneumatic fasteners may be specified.

2. Following Carlisle’s Detail TL-1, fasten consecutive Geomembrane sections and overlap adjoining membrane as shown.

3. Weld overlapping membrane with a Hand Held Welder and apply welding rods to conceal exposed scrim.

4. To terminate the membrane along the top of the wall, prime the concrete surface and install the Sure-Seal Pressure-Sensitive Flashing. Fasten the Geomembrane using 6 mm x 50 mm (1/4 inch x 2 inch) stainless steel bar and stainless steel fasteners to achieve constant compression against the Pressure-Sensitive Flashing.

5. After removal of accumulated debris on the horizontal surface of the tank, loose lay the geotextile fabric overlapping edges approximately 30 cm (12 inches). Extend fabric up the vertical sides of the tank approximately 5 cm (2 inches).

6. Install Geomembrane loose-laid over the protection fabric overlapping adjoining membrane sheets approximately 40 mm (1-1/2 inches) or 100 mm (3-3/4 inches) to accommodate for a single or a double hot air weld.

7. Form all inside corners using 3 mm (.12 inches) thick GeoFlash Flashing and seal all edges with welding rods after probing the seams.

8. Overlay hot air welded seams, if necessary, using 1 mm (.040 inches) non-reinforced GeoFlash Flashing and seal edges on all sides with welding rods.

9. Inlet/outlet pipes and overflow drains should be terminated in accordance with the Carlisle applicable details using the 3 mm (.12 inches) thick GeoFlash Flashing.

B. Reservoirs, Ponds, etc.
1. For earth-dug or reservoirs with structural concrete substrates, follow substrate preparation outlined in Article 3.02. Comply with specifier’s requirements concerning the appropriate Geomembrane type, color and thickness.

2. Position 3.7 m (12 feet) wide Geomembrane loose-laid directly over the properly prepared substrate or in conjunction with geotextile fabric.

3. Adjoining sheets of geotextile fabric, if used, must be overlapped approximately 30 cm (12 inches). Geomembrane may be overlapped a minimum of 50 mm (2 inches) or 120 mm (4-1/2 inches) to accommodate for a single or double weld of 40 mm (1-1/2 inches) for each weld.

4. Using the appropriate Automatic Heat Weld, weld the Geomembrane in accordance with welding procedures outlined in Paragraph 3.03.C.

5. Terminate membrane into an earth-dug trench surrounding the perimeter of the reservoir or pond. Reservoirs with a structural concrete substrate, may be terminated using a mechanical bar termination consisting of 6 mm x 50 mm (1/4 inch x 2 inch) stainless steel or aluminum bar fastened with an appropriate fastener to maintain constant compression on the Water Cut-Off Mastic. Refer to Detail L1-B.

   **Note:** Sure-Seal Pressure-Sensitive Flashing in conjunction with Sure-Seal HP Primer may be used as a substitution to the Water Cut-Off Mastic when terminating the Geomembrane. PT 304 Sealant should also be used to seal the edge of the membrane against the structural concrete.

6. Flash all penetrations through the Geomembrane with 3 mm (.12 inch) thick GeoFlash and seal all edges with welding rods.

7. For ponds and reservoirs with floating covers, the cover must be sized accordingly to avoid stretching when water levels drop. Drains connected to outlet pipes should also be incorporated at each corner to prevent accumulation of rainwater that may promote insect infestation.

   **Note:** Geomembrane .8 mm (.036 inch) thick, is not recommended for use as a floating cover. Use either 1.1 mm (.045 inch) or 1.5 mm (.060 inch) thick Geomembrane.

C. **Hot Air Welding Procedures**

   Use appropriate Automatic Hot Air Welding Machine to achieve a single or double weld as required by the specifier. On vertical surfaces of the tank or when working on slopes greater than 30 degrees, hand held welders should be used.

1. Check the surfaces of the Geomembrane to be hot air welded to ensure they are properly prepared.

2. The surfaces to be hot air welded must be clean. Membrane overlaps that become contaminated with field dirt may be cleaned with warm soapy (non-abrasive soap) water, rinsed with clean water and wiped dry with a clean HP Splice Wipe.

3. Weathered Membrane Cleaner must be used to remove surface oxidation (may result after 7 days of exposure to the elements) of Geomembrane that may occur with exposure to heat and sunlight. Field dirt that may have contaminated overlaps may also be removed with the Weathered Membrane Cleaner.

   a. Apply Weathered Membrane Cleaner to the surface of the membrane which has been exposed using a clean HP Splice Wipe or other white rag and wipe along the direction of the seam.

   If natural fiber rags are used, they must be white to prevent fabric dye from discoloring the membrane.
Prior to hot air welding, wipe the surface where Weathered Membrane Cleaner has been applied with a clean, dry HP Splice Wipe or other white rag to remove cleaner residue.

b. Weathered Membrane Cleaner will achieve approximately 183 m (600 linear feet), one surface, of coverage per 3.78 liters (1 gallon) for a standard hot air welded splice area.

4. Hot Air Welder Set Up

a. Before the machine is connected to the power source, make sure it is switched off to prevent a power surge that could damage the unit. Turn the unit on and allow the blower/heater unit to warm up for approximately 5 to 10 minutes to reach operating temperature.

b. Clean the heat nozzle with a wire brush to remove any build-up of membrane, as needed.

c. To extend the life of the heating element of the Hot Air Welding Equipment, always turn the temperature adjustment down so the welder can cool prior to switching the machine off.

d. Follow all care and maintenance instructions recommended by the respective manufacturer.

e. It is recommended that two Automatic Hot Air Welding Machines and two generators be available at the project site in the event of mechanical failure.

5. Membrane Welding

a. Prepare the Automatic Hot Air Welding Machine and allow it to warm for approximately 5 to 10 minutes to reach operating temperature.

b. Position the Automatic Hot Air Welding Machine properly prior to seaming with the guide handle pointing in the same direction the machine will move along the seam.

c. Lift the overlapping membrane sheet and insert the blower nozzle of the Automatic Hot Air Welding Machine between the overlap. Immediately begin moving the machine along the seam to prevent burning the membrane.

d. Proceed along the seam ensuring that the small guide wheel in front of the machine aligns with the edge of the top membrane sheet. Guide the machine from the front only.

CAUTION: Ensure the power cord has plenty of slack to prevent dragging the machine off course (which could result from a tightly stretched cord).

e. At all splice intersections, roll the seam with a silicone roller to ensure a continuous hot air welded seam (the membrane should be creased into any membrane step-off with the edge of the silicone roller). A false weld may result due to surface irregularities created by multiple thicknesses of Geomembrane sheets.

f. To remove the Automatic Hot Air Welding Machine from the finished splice, stop the movement of the machine and immediately remove the nozzle from the seam area.

g. Mark the end of the hot air welded seam with a water-soluble marker for easy identification. A Hand Held Welder will be necessary to complete the weld in the area between where the Automatic Hot Air Welding Machine is stopped and restarted.
6. **Seam Testing**

A cotter pin puller is recommended to be used to probe all **single** hot air welded seams. **Double** hot air welded seams should be tested using pressurized air that is forced between the two hot air welds. Probing and air testing of all seams must be done once hot air welds have thoroughly cooled.

7. **Welding Rod Extrusion**

Using an extrusion welder, apply welding rods to all cut edges of reinforced membrane where the scrim is exposed and to all splice intersections as well as flashing details.

### 3.04 SURE-SEAL EPDM MEMBRANE APPLICATION (For Reservoirs and Ponds only)

#### A. General

1. Reinforced Sure-Seal EPDM membrane shall be used for lining of ponds with side slopes exceeding 30° and assembling of floating covers. Ponds with side slopes less than 30° may incorporate the use of a non-reinforced membrane.

2. Prior to liner installation, complete all excavation work inside and around the perimeter of the pond or reservoir. Refer to Article 3.02, Substrate Preparation in this section for applicable requirements.

3. Ensure the substrate is clean, smooth, dry and free of projections (i.e., fins, sharp edges), contaminants, foreign material, oil and grease.

4. Where applicable over structural concrete substrates, install 339 g/m² (10 oz/square yard) geotextile fabric loose-laid with adjoining sheets overlapped approximate 30 cm (12 inches). Extend fabric up the sides of pond as shown in the applicable Carlisle Detail.

5. Unroll EPDM membrane without stretching and allow to relax approximately 1/2 hour. Overlap adjoining membrane sheets approximately 17 - 20 cm (7 - 8 inches) in order to achieve a 15 cm (6 inch) wide minimum splice.

6. Assemble splices using either EP-95 Splicing Cement or 15 cm (6 inch) wide SecurTAPE.

#### B. EPDM Membrane Adhesive Splicing

1. Remove dirt or excess dust from the mating surfaces of the overlapping sheets by wiping with Sure-Seal HP Splice Wipes or clean natural fiber rags. The splice area of both membrane sheets must be cleaned by scrubbing with Splice Wipes or clean natural fiber rags saturated with Sure-Seal Splice Cleaner, Weathered Membrane Cleaner or HP-250 Primer. Extra cleaning is required along a factory seam that intersects a splice area.

2. When cleaning the membrane surface as stated above, check the membrane surfaces to verify adequate cleaning procedures are maintained. Both sides of the **Sure-Seal EPDM membrane** must be solid black in color with no streaking. **Hold** the top membrane sheet back as the cleaning and scrubbing process continues along the length of the splice so that both mating surfaces may be cleaned at approximately the same time.

3. **Stir Splicing Cement thoroughly** scraping the sides and the bottom of the can (minimum 5 minutes stirring is recommended). Properly stirred Sure-Seal EP-95 Splicing Cement will have a solid black appearance with no heavier black material remaining on the bottom or sides of the can. Membrane surfaces must be visibly dry and clean as stated previously.
4. **Apply** Splicing Cement to both mating surfaces with the 10.5 cm (4 inch) wide, 13 mm (1/2 inch) medium nap roller (provided in each carton of Splicing Cement). Apply cement smoothly, continuously and relatively even to achieve a **heavy** coat.

   a. Do not allow the cement to glob or puddle.

   b. When a roller cannot be effectively used (at angle changes, corners, etc.), a 13 mm (1/2 inch) thick paint brush may be used to apply Splicing Cement; however, the Splicing Cement must be applied to achieve a **smooth surface** without brush marks.

   **Note:** When temperatures are expected to fall below 5°C (40°F), the use of a paintbrush must be limited (angle changes and corners) since brush marks will not bleed out.

   c. One-gallon container of Splicing Cement, applied in a **heavy**, relatively even coat, will achieve the approximate coverage rate of 23 m (75 linear feet).

5. **Allow** the cement **to dry until it is tacky** but will not string or stick to a dry finger touch and will not move when pushed with a dry finger.

6. **Do not allow the splicing cement to over-dry before mating the two surfaces** (over-dried Splicing Cement will not be tacky). If splice over-drying occurs, apply a thin freshener coat of Splicing Cement over the dried cement at half the coverage rate listed above. To avoid over-drying, Carlisle recommends using a minimum two-man installation procedure for splices longer than 3 m (10 feet).

7. Due to solvent flash off, condensation may form on freshly applied Splicing Cement when the ambient temperature is near the dew point. If condensation develops, the application of Splicing Cement must be discontinued since proper adhesion will not be achieved. Allow the surface to dry and apply a thin freshener coat of Splicing Cement as stated above to the previously coated surface when conditions allow.

8. **Just prior to closing the splice**, apply a bead of In-Seam Sealant™ approximately 3 to 6 mm (1/8 to 1/4 inch) in diameter along the center of the splice. Do not allow In-Seam Sealant to become overly dry.

   a. Approximately 23 m (75 linear feet) of coverage per tube can be achieved when a minimum 3 mm (1/8") diameter bead of In-Seam Sealant is applied.

   b. Maintain a continuous bead of In-Seam Sealant on all membrane splices including at splice intersections. Refer to appropriate detail.

   c. During splice cleaning procedures, Sure-Seal HP Splice Wipes contaminated with In-Seam Sealant cannot be reused for the application of Splice Cleaner or Primer.

9. **Roll the top membrane sheet** onto the mating surface. Take care not to stretch or wrinkle the membrane sheet to avoid a fishmouth in the field splice.

10. **Assemble** the seam with hand pressure by wiping toward the splice edge.

11. **Immediately roll the splice** with a 5 cm (2 inch) wide steel roller, using positive pressure, toward the outer edge of the splice. DO NOT ROLL PARALLEL TO THE SPLICE EDGE. On a completed splice, the In-Seam Sealant must remain evident and be sensitive to the touch.

12. Wait at least 2 hours and apply a 5/16" (minimum 1/4") diameter bead of Lap Sealant to completely cover the splice edge. When a 5/16" diameter bead of Lap Sealant is applied, approximately 22 linear feet of coverage per tube can be achieved. Feather the Lap Sealant with the specially preformed tool or nozzle (included in the Lap Sealant cartons) so the high point or crown of the Lap Sealant is located over edge of splice.
C. EPDM Membrane SecurTAPE Splicing

**Tape splices must be a minimum of 15 cm (6 inches) wide** using 6" wide SecurTAPE extending 3 mm (1/8 inch) minimum to 13 mm (1/2 inch) maximum beyond the splice edge. **Prior to SecurTAPE application, the splice area must be primed with Sure-Seal HP-250 Primer.** In warmer temperatures, it is recommended to keep SecurTape in a shaded area out of direct sunlight.

1. At membrane overlaps, mark the bottom sheets with an indelible marker 13 mm (1/2 inch) from the top sheet edge. The pre-marked line on the membrane edge can also be used as a guide for positioning splice tape.

   **Apply Primer to achieve a thin, even coat** on both membrane surfaces. Splice area must be uniform in color, streak-free and free of globs or puddles.

   a. HP-250 Primer shall be applied with HP Splice Wipes. As an option, Sure-Seal Primer Pads can be used to apply HP-250 Primer.

      **Note:** Primer Pads clean approximately 15 m (50 linear feet) for a 15 - 20 cm (6" - 8") wide splice area. Pads can be flipped over and used for another 15 m (50 linear feet) of splice.

   b. Hycron® Gloves (available from Carlisle) are required for hand protection when primer is used.

2. The coverage rate for HP-250 Primer is approximately 23 m² (250 square feet) per gallon. This equates to approximately 90 m (300 linear feet) per gallon for a completed 8 cm (3 inch) wide splice area (primer applied on 13 cm (5 inches) wide area on both membrane surfaces).

3. **Allow** Primer to dry until tacky but does not transfer to a dry finger touch.

   **Note:** Due to solvent flash-off, condensation may form on freshly applied HP-250 Primer when the ambient temperature is near the dew point. If condensation develops, the application of Primer and SecurTAPE must be discontinued since proper adhesion will not be achieved. Allow the primer surface to dry and apply a thin freshener coat of HP-250 Primer to the previously coated surface and apply SecurTAPE when conditions allow.

4. **Unroll** approximately 1 m (3 feet) of SecurTAPE. Align release film with marked line and press tape down to bottom sheet using firm, even, hand pressure. Continue for the length of the splice. Tape roll ends must be overlapped 2.5 cm (1 inch). Allow top sheet to rest on release film on backside of tape.

   **Note:** Tape placement is critical to obtain a minimum splice width of 15 cm (6 inches). A minimum of 3 mm (1/8 inch) to a maximum of 13 mm (1/2 inch) of tape must extend beyond the splice edge.

5. **Pull** release film from SecurTAPE beneath the top membrane sheet and allow the top sheet to fall freely onto exposed tape.

6. **Press** the top sheet onto the tape using firm, even, hand pressure across the splice towards the splice edge.

7. **Immediately roll** the splice with a 5 cm (2 inches) wide steel roller, using positive pressure. Roll across the splice edge, not parallel to it.

8. **Install** a 15 cm (6 inches) wide section (with rounded corners) of Sure-Seal Pressure-Sensitive Flashing or Sure-Seal Elastoform Flashing over all splice intersections and seal edges of flashing with Lap Sealant.
D. **Terminations and Floating Covers**

Terminate membrane into an earth-dug trench surrounding the perimeter of the reservoir or pond. Reservoirs with a structural concrete substrate, may be terminated using a mechanical bar termination consisting of 6 mm x 50 mm (1/4 inch x 2 inch) stainless steel or aluminum bar fastened with an appropriate fastener to maintain constant compression on the Water Cut-Off Mastic. Refer to Detail L1-B.

1. Flash all penetrations according to the applicable detail using either Sure-Seal Uncured Elastoform Flashing or Sure-Seal Uncured Pressure-Sensitive.

2. For ponds and reservoirs with floating covers, the floating covers must be assembled using 1.1 (.045”) or 1.5 (.060”) thick reinforce Sure-Seal EPDM.

3. The floating covers must be terminated into a burial trench around the perimeter of the pond or reservoir and sized according to prevent stretching when water levels drop.

4. Drains connected to outlet pipes should also be incorporated at each corner to prevent accumulation of rainwater that may promote insect infestation.
Sure-Seal® EPDM and Geomembrane™
Water Containment and Lining System
Details

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April 2003

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L-1-B Membrane Application – Concrete Base

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L-2-B EPDM Membrane Tape Splice  
L-2-C/TL-2 Geomembrane Splice

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L-4 Pipe Terminations Through Liner  
L-5 Inlet/Outlet Through Liner  
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L-2-C/TL-2 Geomembrane Splice  
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MEMBRANE APPLICATION – CONCRETE BASE

2. WATER CUT-OFF MASTIC MUST BE HELD UNDER CONSTANT COMPRESSION.

1. 600 mm (24 in) MIN. FREEBOARD CLEARANCE TO WATER SURFACE IS REQUIRED.

NOTES:

MECHANICAL

SEALANT (USED WITH GEO MEMBRANE)
SURE-SEAL OR GEO

SURE-SEAL AS SEQUENCED

SURE-SEAL WATER CUT-OFF MASTIC

CONCRETE FASTENER

6 mm x 50 mm (1/4 in x 2 in) MIN.
MUTUAL TRANSITION BARS

SURE-SEAL LAP SEALANT OR CONWELL 1020

SURE-SEAL OR GEO (SEE SEQUENCED)

GEOTEXTILE SEPARATION LAYER

MIN. 399 g/m² (10 oz/lf)

NO. 8 X 1 1/2" RIVETS 24" C/C

(24 in)

600 mm MIN.
1. Membrane splice procedure is for splices between cured EPM membranes.

2. Apply splicing cement over entire 150 mm (6 in) wide minimum splice area.

3. IN-SEAM SEALANT SHALL BE CONTINUOUS ALONG THE LENGTH OF THE SPlice.

NOTES:

- MIN. 75 mm (3 in) EPM membrane
- MIN. 150 mm (6 in) IN-SEAM SEALANT
- MIN. 33 g/m² (1 oz/yd²) EPM membrane
- MIN. 75 mm (3 in) SPLICING CEMENT
- MIN. 33 g/m² (1 oz/yd²) EPM membrane
- MIN. 75 mm (3 in) SPLICING CEMENT
- MIN. 75 mm (3 in) SPLICING CEMENT
- MIN. 75 mm (3 in) SPLICING CEMENT
- MIN. 75 mm (3 in) SPLICING CEMENT
EPDM MEMBRANE TAPE SPlice

L-2A

NOTES:

1. Apply lap sealant at lap splice. Apply a minimum of 25 mm (1 in.) wide.

2. Securant is to be overlapped a minimum of 25 mm (1 in.) prior to installation of Securant. Apply sure-seal.

3. At each cut, piece overlap with full adhesive interlock. Apply lap sealant as shown above.

4. Lap sealant is required on cut edges of reinforced EPDM membrane.):

OVERLAP
Approx. 150 mm (6 in.)

15 mm (1/2 in.)

3 mm min. (1/8 in.)

MIN. 75 g/m (10 oz/yd²)

MIN. 50 g/m (7 oz/yd²)
SURE-WELD TO MEMBRANE SPlice

L-2-C

IS REQUIRED ON CUT EDGES OF GEO MEMBRANE.
APPROXIMATELY 3 mm (1/8 in.) DIAMETER BEAD OF CUT-EDGE SEALANT

NOTE:

MIN. 40 mm (1-1/2 in.)

MIN. 3.39 lb/100 ft. (10 oz/yd)

GEO TELSPRAZION LAYER

GEO

MINIMUM 40 mm (1-1/2 in.)

WIDE HOT AIR WELD

CUT-EDGE SEALANT
GAS VENT DETAIL

1. GAS VENT MUST BE ABOVE MAXIMUM WATER LEVEL.

2. DETAIL NOT FOR USE IN POSSESS WITH FLOATING COVERS.

NOTES:
PROFILE VIEW

PLAN VIEW

CONSTANT ELEVATION AT BASE OF SLOPE
Splice Intersection

1. Position sheets and hot air weld the reinforcement membrane at a minimum of 40 mm (1-1/2"").

2. Install a 150 x 150 mm (6" x 6") intersection ("T-Joint") as shown.

- Flashing centered over splice
- Sure-Weld non-reinforced section
- Flashing non-reinforced 6" x 6" Sure-Weld
- MIN. 1-1/2"
- MIN. 1-1/2"
- HOT AIR WELD
- MINIMUM 40 mm (1-1/2"")

END LAPS OVERLAP AT 50 mm (2")
INSIDE CORNER FLASHING

APPROXIMATELY 13 mm (1/2 in) DIAMETER BEAD OF COT-EDGE SEALANT IS REQUIRED ON CUT

NOTE:

EDGES OF COT MEMBRANE

(10 oz/yd²)
390 g/m²
LATEX LAYER
SEPARATION
ADHESIVE
NON-HARDENED FLASHING
CONNECT ON WEB (FLASCATIONS)
SURE-WEB® INSIDE OUTSIDE

APPROX
50 mm (2 in)

APPROX
ACO
MEMBRANE

CUT ALONG LINES

APPROX 20 mm (2 in)

CUT CHARGE LINE

FLASHING HEIGHT

MEMBRANE

0.03
Section III
TUNNEL WATERPROOFING SYSTEM
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August 2002

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Details

T-001 Tunnel Cross Section
T-002 Waterproofing Membrane “Tab”
T-003 “Tab” Spacing
T-004 Tunnel Air Shaft
T-005 Electrical Conduit Penetration
This specification outlines requirements for Carlisle's Tunnel Waterproofing System and is intended for use by engineers and waterproofing contractors involved with design or installation of underground tunnels.

**PART I GENERAL**

**1.01 DESCRIPTION**

This Tunnel Waterproofing System consists of 1.5 mm (.060”) thick 2.4 m (8 feet) wide scrim-reinforced Sure-Weld™ Thermoplastic Polyolefin (TPO) membrane installed in conjunction with CCW Sure-Drain. The Sure-Drain underlayment is anchored to structural concrete shell of the tunnel and the membrane is fastened through tabs hot air welded to the backside of the membrane approximately 1.2 m (4 feet) on center. Both underlayment and the membrane are fastened with pneumatic fasteners and 5 cm (2 inch) diameter heavy galvanized or stainless steel plates. Consecutive sheets of Sure-Weld membrane are overlapped a minimum of 10 cm (4 inches) and hot air welded using an Automatic Wedge Welding Machine resulting in a double weld 30 mm (1-1/4 inch) wide each.

**1.02 QUALITY ASSURANCE**

A. The Sure-Weld membrane meets ASTM E-108 as a Class A, B or C external fire rating, Underwriters Laboratories (UL) 790 and UL 263 (ASTM E 119) “Fire Test of Building Construction and Materials” with an exposure rating of 1300°F 704°C (1300°F) internal temperature and external temperature of 176°C (350°F).

B. This system must be installed by an Authorized Contractor in compliance with project specification and drawings. Any deviations made from this published specification must be approved by Carlisle.

C. Prior to installation, project shop drawings may be submitted to the manufacturer for review.

D. Comply with applicable regulatory requirements, applicable codes, ordinances and laws.

E. On-site technical assistance is available for a charge. Projects where technical assistance is required must have a manufacturer’s approved drawing.

**1.03 SUBMITTALS**

A. To ensure compliance with the applicable design criteria, project drawings, specification and pertinent details may be submitted for Carlisle’s review.

B. Requests for certification and/or formal drawing approval must be accompanied by a copy of the project specification and details. Shop drawings of maximum size 43 cm x 56 cm (17” x 22”) are preferred.

C. Substitution of a non-Carlisle supplied product is permitted upon review and approval. Samples of the product along with technical literature may be forwarded to Carlisle for consideration.

**1.04 PRODUCT DELIVERY, STORAGE AND HANDLING**

A. Deliver materials to the job site in the original, unopened containers labeled with the manufacturer's name, brand name and installation instructions.
B. Job site storage temperatures in excess of 32°C (90°F) may affect shelf life of curable materials (i.e., adhesive, sealants and cleaners).

C. When sealants or cleaners are exposed to lower temperatures, restore to a minimum of 16°C (60°F) before use.

1.05 JOB CONDITIONS

A. Comply with applicable codes and regulations pertaining to the operation and storage of heavy equipment.

B. Coordination between various trades is essential to prevent damage to the waterproofing membrane.

C. Do not allow waste products (i.e., petroleum, grease, oil, solvents) or direct steam venting to come in contact with the waterproofing membrane.

D. Do not expose membrane and accessories to constant temperatures in excess of 82°C (180°F).

E. Prior to the use of any product, consult the Material Safety Data Sheet and Technical Data Bulletin for cautions and warnings. Store adhesives, sealants and cleaners away from all sources of heat, flame or sparks.

F. Cold temperatures will not restrict the installation of this system. Follow specified precautions for storage of materials.

G. Coordinate waterproofing work with other trades. The contractor shall have sole right of access to the specified areas for the time needed to complete the application.

H. Maintain work area in a neat and orderly condition, removing empty containers, rags and debris daily from the site.

1.06 WARRANTY

A 20 year Membrane Material Warranty is available for a charge. The Material Warranty will cover normal deterioration and is pro-rated.

PART II PRODUCTS AND RELATED EQUIPMENT

2.01 GENERAL

The components of this tunnel waterproofing system are to be products of Carlisle or accepted by Carlisle as compatible. The installation, performance or integrity of products by others, when selected by the specifier and accepted by Carlisle, is expressly disclaimed by Carlisle.

2.02 MEMBRANE

Sure-Weld, white, reinforced 1.5 mm (.060") thick Thermoplastic Polyolefin (TPO) membrane is used for this system. Membrane is available in widths of 2.4 m (8') and lengths of 30 m (100'). See membrane physical properties, below.
<table>
<thead>
<tr>
<th>Property (Metric-SI Units)</th>
<th>Test Method</th>
<th>Property of Unaged Sheet</th>
<th>Property After Aging (1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tolerance on Nominal Thickness, %</td>
<td>ASTM D 751</td>
<td>±10</td>
<td>±10</td>
</tr>
<tr>
<td>Thickness Over Scrim, min. in. (mm)</td>
<td>ASTM D 4637</td>
<td>0.015 (0.381) Min.</td>
<td>0.018 (0.457) Typ.</td>
</tr>
<tr>
<td>Solar Reflectance (albedo X 100), %</td>
<td>ASTM E 903</td>
<td>White - 80 Typ.</td>
<td></td>
</tr>
<tr>
<td>Breaking Strength, min, lbf (kN)</td>
<td>ASTM D 751 Grab Method</td>
<td>225 (1.0) Min.</td>
<td>225 (1.0) Min.</td>
</tr>
<tr>
<td>Elongation at Break of Fabric, min, %</td>
<td>ASTM D 751</td>
<td>25 Typ.</td>
<td>25 Typ.</td>
</tr>
<tr>
<td>Tearing Strength, min, lbf (N) 8&quot; by 8&quot; specimen</td>
<td>ASTM D 751 B Tongue Tear</td>
<td>55 (245) Min. 130 (578) Typ.</td>
<td>55 (245) Min. 130 (578) Typ.</td>
</tr>
<tr>
<td>Brittleness Point, max, EF (EC)</td>
<td>ASTM D 2137</td>
<td>-40 (-40) Min. 50 (-40) Typ.</td>
<td>-50 (-40) Typ. 50 (-46) Typ.</td>
</tr>
<tr>
<td>Linear Dimensional Change (shrinkage), %</td>
<td>ASTM D 1204</td>
<td>+/- 1.0 Max. 0.5 Typ.</td>
<td></td>
</tr>
<tr>
<td>Ozone Resistance*</td>
<td>ASTM D 1149</td>
<td>No Cracks</td>
<td>No Cracks</td>
</tr>
<tr>
<td>Specimen wrapped around 3 in. mandrel</td>
<td>ASTM D 471</td>
<td>4.0 Max.</td>
<td>2.0 Typ.</td>
</tr>
<tr>
<td>Resistance to Water Absorption*</td>
<td>ASTM D 3274</td>
<td>9 - 10 Typ.</td>
<td></td>
</tr>
<tr>
<td>After 7 days immersion @ 158° F (70°C) Change in mass, max, %</td>
<td>ASTM D 1876</td>
<td>40 (7.0) Min. 60 (10.5) Typ.</td>
<td></td>
</tr>
<tr>
<td>Field seam strength, lbf/in. (kN/m) Seam tested in peel</td>
<td>ASTM D 1876</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water vapor permeance, Perms</td>
<td>ASTM E 96</td>
<td>0.10 Max. 0.05 Typ.</td>
<td></td>
</tr>
<tr>
<td>Puncture resistance, lbf (N)</td>
<td>FTM 101C Method 2031</td>
<td>250 (1110) Min. 300 (1330) Typ.</td>
<td>250 (1110) Min. 300 (1330) Typ.</td>
</tr>
<tr>
<td>Xenon-Arc, 5040 kJ/m² total radiant exposure visual condition at 10X</td>
<td>ASTM G 26</td>
<td>No Cracks</td>
<td></td>
</tr>
<tr>
<td>No loss of breaking or tearing strength</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(1) Aging conditions are 28 days at 240° F (116° C) equivalent to 400 days at 176° F (80° C) for breaking strength, elongation, tearing strength, linear dimensional change, ozone and puncture resistance.

(2) Approximately equivalent to 8000 hours exposure at 158° F (70° C) black panel temperature. 12/98

### 2.03 OTHER MATERIALS

**A. CCW Sure-Drain-V Drainage Composite Board:** A high-impact polystyrene core covered on one side with a non-woven, needle-punched polypropylene filter fabric and on the other with a solid polymeric film. Available in rolls of 1.2 m (4 feet) by 15 m (50 feet)

**B. Sure-Weld Flashing:** Sure-Weld non-reinforced flashing is available in rolls 30 cm (12 inches) and 60 cm (24 inches) wide by 15 m (50 feet) long. Flashing is used for splice intersections and electrical conduit penetrations.

**C. Water Cut-Off Mastic:** Used as a mastic to prevent moisture migration at membrane and flashing terminations with a coverage rate of approximately 3 m (10 feet) per tube or 30 m (100 feet) per 3.78 l (1gallon).

**D. CCW-102C Sealant:** Used to seal membrane at termination bars with a coverage rate of approximately 3 m (10 feet) per tube.

**E. Weathered Membrane Cleaner:** Used to prepare membrane that has been exposed to the elements for approximately 7 days prior to hot air welding at an approximate coverage rate of 300 m (1000 linear feet) per 3.78 l (1 gallon) on a 10 cm (4 inch) wide surface.

**F. Water Swelling Waterbar (by others):** Used to provide efficient waterproofing of construction joints. When in contact with water, the waterbar will slowly increase in volume (20% to 200% depending on water salt concentration). The swelling action (limited to the side exposed to water) will cause the waterbar to profile itself into the joint filling all cavities and effectively stop water seepage. For added safety, wider joints can be filled using 2 waterbars. The Water Swelling Waterbar is used at the base of electrical conduits engaging through the shotcrete substructure and at any other joints or gaps.
### G. Aerosmith® 144 Series Fasteners and Plates

A fastener used for the securement of the Drainage Board and the Sure-Weld Waterproofing Membrane available in lengths up to 65 mm (2-1/2 inches) with 4 mm (.14 inch) shank diameter and head size of 8 mm (5/16 inch). Fasteners and Plates are available in steel or stainless steel. Listed below is a fastener performance chart based on 19 mm or 25 mm fastener penetrations into concrete from 141 kg/cm² to 211 kg/cm². The fasteners are installed in conjunction with heavy galvanized or stainless steel plates that are 5 cm (2 inches) in diameter.

<table>
<thead>
<tr>
<th>Fastener Requirements</th>
<th>Installed in Stone Aggregate Concrete</th>
<th>Installed in Lightweight Aggregate Concrete</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>141 kg/cm² (2000 psi)</td>
<td>211 kg/cm² (3000 psi)</td>
</tr>
<tr>
<td></td>
<td>280 kg/cm² (4000 psi)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>211 kg/cm² (3000 psi)</td>
<td></td>
</tr>
<tr>
<td>Series</td>
<td>Shank Dia.</td>
<td>Min. Penetration</td>
</tr>
<tr>
<td>144 Fasteners</td>
<td>4 mm (3/4 Inch)</td>
<td>19 mm (3/4 Inch)</td>
</tr>
<tr>
<td></td>
<td>25 mm (1 Inch)</td>
<td>25 mm (1 Inch)</td>
</tr>
</tbody>
</table>

### I. Inside/Outside Corners

A pre-molded corner flashing used for outside corners of air shafts.

#### 2.04 RELATED EQUIPMENT

**A. Generator/Electrical Requirements**

Power supplies do not typically provide the proper amount of power necessary for consistent hot air welding. The use of a portable generator conforming to the following guidelines is strongly advised.

1. **A minimum 6500 watt generator** with a minimum output of 210 volts is required for one Automatic Hot Air Welding Machine. Reduced power availability will result if additional equipment is connected to the generator and may result in faulty hot air welded seams. GFI (Ground Fault Interrupter) protection is recommended. Additional generators will be required for operating other power tools and hand held hot air welders.

2. **Electrical cords** (3 conductor) of the maximum length indicated must be used with the corresponding wire as listed below:

<table>
<thead>
<tr>
<th>Maximum Length</th>
<th>Wire Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 m (50 foot)</td>
<td>#12</td>
</tr>
<tr>
<td>30 m (100 foot)</td>
<td>#10</td>
</tr>
<tr>
<td>90 m (300 foot)</td>
<td>#8</td>
</tr>
</tbody>
</table>

3. **A minimum 3,000 watt generator** may be used to power a maximum of two hand held welders as long as no other equipment is connected. This generator should service a minimum of 110 volts and be GFI (Ground Fault Interrupter) protected.

**Electrical cords** (3 conductor) of the maximum length indicated must be used with the corresponding wire as listed below:

<table>
<thead>
<tr>
<th>Maximum Length</th>
<th>Wire Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 m (50 foot)</td>
<td>#14</td>
</tr>
<tr>
<td>30 m (100 foot)</td>
<td>#12</td>
</tr>
</tbody>
</table>

For extension cords longer than 30 m (100 feet), consult an electrician or electrical contractor to ensure proper size of generator and wire.
B. **Automatic Wedge Welding Machine:** A lightweight, approximately 7 kg (15.75 pounds) welding machine with a maximum temperature output of 420° C (788° F) capable of delivering a double hot air weld 30 mm (1-1/4 inch) wide each. The Automatic Wedge Welding Machine is manufactured by Leister and could be furnished by Carlisle. A welding seam test kit should be made available on site to ensure the integrity of the double welded seam. Consult a Leister Manufacturer Representative for appropriate test kit and recommended air pressure.

C. **Hot Air Hand Welder:** An electrically powered, hand-held device that utilizes an electrical resistance heating element or heater and fan-forced super heated air to hot air weld Sure-Weld membrane and flashing. A hand-held **silicone** rubber roller is used in conjunction with the welder to apply the pressure that fuses the heated membrane surfaces to each other. The hand-held welder is typically used for seam overlays at “T” joints and flashing of electrical conduits and around tunnel airshafts.

D. **Seam Prober:** Probing of hot air welded seams overlays is essential to ensure the continuous watertight seal at “T” joints and intersections between hot air welded seams and other penetrations (i.e., electrical conduit, air shafts, etc.). The use of a cotter pin puller is the recommended tool.

E. **Silicone Rubber Roller:** A 40 mm (1-1/2 inch) wide rubber roller used for rolling hot air welded overlays at “T” joints, patches and flashing at airshafts and electrical conduits.

F. **Aerosmith Fastening System:** A pneumatic fastening tool able to deliver 40 fasteners per minute into concrete surfaces with compressive strength up to 352 k/cm² (5000 psi) with a minimum fastener penetration of 19 mm (3/4 inch)

PART III EXECUTION

3.01 GENERAL

Prior to commencement of the work, manufacturer’s Material Safety Data Sheets, Technical Data Bulletins and product labels should be referenced for cautions and warnings and specific installation requirements.

Comply with shotcrete manufacturer’s published specification to ensure proper curing of the substructure prior to the installation of the CCW Sure-Drain and the Sure-Weld Membrane.

3.02 INSTALLATION

A. **CCW Sure-Drain-V Drainage Board Installation**

1. Unroll and place CCW Sure-Drain with the geotextile filter fabric side against the tunnel substructure. The drainage board can be installed horizontally or vertically.

2. At end rolls, peel back filter fabric and overlap two rows of dimples approximately 40 mm (1-1/2 inches) and press to interlock the panels.

3. Along the length of the drainage board, position drainage panels so the side of the panel with a flange overlaps the side of the panel without a flange.

4. Fasten drainage board with pneumatic fasteners and fastening plates 1.2 m (4 feet) on center in all directions.

B. **Wedge Welding Set Up**

Due to a variety of heat welding equipment available, manufacturer’s operating instructions and safety procedures should be referenced. Listed below are additional recommendations intended to extend life expectancy of welders and ensure safe operation.
1. Before the machine is connected to the power source, make sure it is switched off to prevent a power surge that could damage the unit. Turn the unit on and allow the blower/heater unit to warm up for approximately 5 to 10 minutes to reach operating temperature.

2. Clean the heat nozzle with a wire brush to remove any build-up of membrane, as needed.

3. To extend the life of the heating element of the Hot Air Welding Equipment, always turn the temperature adjustment down so the welder can cool prior to switching the machine off.

4. Follow all care and maintenance instructions recommended by the respective manufacturer.

5. It is recommended that two Automatic Hot Air Welding Machines and two generators be available at the project site in the event of mechanical failure.

C. **Sure-Weld Membrane Installation**

The installation of the Sure-Weld membrane can be accomplished with a continuous sheet or multiple sheets. This can be determined by calculating the length of the tunnel arc.

1. Unroll Sure-Weld Membrane and cut to proper length if necessary.

2. With the black side of the membrane up, chalk lines so tabs, 15 cm (6 inches) wide and 23 cm (9 inches) long, can be positioned and welded at 1.2 m (4 feet) on center in all directions across the field of the sheet and 60 cm (24 inches) from all edges.

3. Using a hand held welder, weld one end of each tab approximately 40 mm (1-1/2 inches) in width to the back side of the membrane.

4. Position the back side of the membrane against the previously installed drainage board extending one end of the membrane into the drainage pit.

5. Working from the bottom, begin securing the each row of tabs by fastening through the center of the tab with pneumatic fasteners and fastening plates.

6. Prior to proceeding with the next row of tabs, fold the end of the tab over fastener head and plates to protect membrane against abrasion.

7. Working upward, secure consecutive rows until all tabs are secured.

8. With an overlap of 10 cm (4 inches), install adjacent membrane in a similar fashion. Install consecutive sheets prior to welding.

7. Weld adjoining membranes with a Hot Air Wedge Welder to achieve a double hot air weld 30 mm (1-1/4 inch) wide each.

**Note:** Follow manufacturer’s operating procedures and published instructions to achieve proper temperature output and welding speed. It is advisable to perform various test welds prior to seaming consecutive membrane sheets.

8. Membrane that has been exposed to the elements for approximately 7 days must be prepared with Weathered Membrane Cleaner as follows.

   a. Using a Scotch Brite Pad and Weathered Membrane Cleaner, scrub the area to be welded. (The cleaner will become white with membrane residue during this step of the procedure.)
b. Clean all residue from the area to be welded with a HP Splice Wipe or clean natural fiber (cotton) rag.

c. Weld the cleaned material together with an appropriate hot air welder.

9. Using a compatible test kit and compressed air, examine every seam for defects in the double weld. Defected areas should be repaired using a patch of reinforced membrane large enough to extend 5 cm (2 inches) beyond the defective area. Intersections between the reinforced patch and the hot air welded seam in the membrane should be overlaid with Sure-Weld Flashing.

D. Membrane Flashing

1. Ensure tight fitting between electrical conduits, tunnel air shafts and any other gaps by installing Water Swelling Bar in accordance with manufacturer’s instructions.

2. Flash electrical conduit using uncured non-reinforced Sure-Weld membrane. Refer to Detail T-005.

3. All intersections shall be overlaid with Sure-Weld non-reinforced flashing.

4. Around air shafts additional fasteners and plates shall be incorporated to mechanically secure the membrane approximately 30 cm (12 inches) on center. Sure-Weld Reinforced Membrane shall be used to flash the sidewall of the air shaft extending approximately 5 cm (2 inches) past the plates. Against the sidewall of the air shaft the Sure-Weld membrane is terminated using a 6 mm x 50 mm (1/4 inch x 2 inch) Termination Bar and pneumatic fasteners. Seal the end of the air shaft flashing with CCW-102C Sealant as shown on Detail T-004.
TUNNEL CROSS SECTION

DETAILS T-002 AND T-004:

Waterproofing/Sealing as Shown on

1st and 2nd Options. See Notes on the

Way Section "Thermal Interface" above

Note 4:

1. Install the C/C Primer X with the

Mastic Primer A. See Notes.

2. Install the C/C Primer X with the

Mastic Primer A. See Notes.

3. Install the C/C Primer X with the

Mastic Primer A. See Notes.

4. Space the first row of T-005, 600

mm (9 in) from the toe of the Burke-

Well.

5. Space the first row of T-005, 1200

mm (9 in) from the toe of the Burke-

Well. See Note 4.

6. Space the first row of T-005, 1800

mm (9 in) from the toe of the Burke-

Well. See Note 4.
1. Begin installation of fastening plates approximately 150 mm (6 in) from center of air shaft.

2. Position fastening plates 15 mm to 25 mm (1/2 to 1 in) from edge of waterproofing membrane.

NOTES:

- Cut-off mastic
- Waterproofing membrane
- Reinforcing board
- Concrete wall (by others)
- Tunnel Air Shaft
- Hot Air Weld
- Reenforced Thermoplastic
- Sure-Weld
- Sure-Sleat Water-PROOFING MEMBRANE
- Metal termination bar 6 mm x 50 mm (1/4 in. x 2 in)
- Waterproofing membrane
- Reinforcing board
- Concrete wall (by others)
- Tunnel Air Shaft
- Hot Air Weld
- Reenforced Thermoplastic
- Sure-Weld
- Sure-Sleat Water-PROOFING MEMBRANE
- Metal termination bar 6 mm x 50 mm (1/4 in. x 2 in)
- Waterproofing membrane
- Reinforcing board
- Concrete wall (by others)
- Tunnel Air Shaft
- Hot Air Weld
- Reenforced Thermoplastic
- Sure-Weld
- Sure-Sleat Water-PROOFING MEMBRANE
- Metal termination bar 6 mm x 50 mm (1/4 in. x 2 in)
NOTE

SHEET (SEE DETAIL 1-002)

OVERPUMP AND HOT AIR WELD TO ATTACHING

AREA OF "TAP" TO BE HOT AIR WELD AND WELDED AS SHOWN

NOTE: UNLESS OTHERWISE SPECIFIED, ALL DIMENSIONS ARE IN MILLIMETERS (INCHES) AND REFERENCE POINT IS HORIZONTAL CENTERLINE OF LINING TUBE ALONG TUNNEL CENTERLINE.

DETIAL 1-002:
PLUMBING PIPING EXAMPLES (AS SHOWN ON
REINFORCED MEMBRANE) "TAP" TO THE SURE-WELD
HOT AIR WELD 150 mm x 240 mm (6 in x 9 in) SURE-WELD

MEMBRANE

SURE-WELD REINFORCED

WEATHERPROOFING MEMBRANE

HEAT AIR WELD

APPROX

100 mm (4 in)
MINIMUM 40 mm (1-1/2 in) VERTICAL HOT AIR WELD.
SURE-WELD NON-REINFORCED MEMBRANE WRAPPED AROUND PIPE SHALL HAVE

NOTE:

- Cut-off mastic
- Sure-seal water barrier
- Stainless steel
- Sure-weld non-reinforced membrane
- Reinforced
- DR-1500 drainage board
- CCM Sure-Drain-V
- Wall (BP others)
- Concrete tunnel
- 25 mm (1 in.) min (approx)
- 40 to 90 mm (1-1/2 to 3-1/2 in.)
PART I     GENERAL

1.01 DESCRIPTION

The Sure-Weld FleeceBACK Erosion Control System incorporates 12’ wide .060” thick gray or tan Sure-Weld membrane laminated to a 55 mil non-woven polyester fleece-backing. The 115 mil thick membrane is installed directly over compacted fill treated with herbicide to prevent weed growth. Individual sheets of membrane are anchored with #5 deformed reinforcing bars shop welded to 1/8” x 5” x 5” steel plates. The anchoring plates are spaced 3’ or 5’ on center depending on the location and the reinforcing bars are embedded in the soil approximately 24” deep. Adjoining sheets are heat welded together then seams are overlaid with the 6” wide Pressure-Sensitive TPO Cover Strip. Around the perimeter, the Erosion Control membrane is extended 2’ into a trench and backfilled.

1.02 QUALITY ASSURANCE

A. This system must be installed by a Carlisle Authorized Applicator in compliance with Carlisle’s installation details and project specification as approved by Carlisle. Deviations made from Carlisle's details or approved specification shall be secured in writing prior to commencement of the work.

B. Project specifications and details shall be submitted for Carlisle's approval prior to proceeding with the Erosion Control Membrane installation.

C. Upon completion of the installation, an inspection by a Technical Representative of Carlisle may be requested to ascertain the system has been installed according to Carlisle's specifications and details.

1.03 SUBMITTALS

A. To ensure compliance with Carlisle's warranty requirements, the following projects should be forwarded to Carlisle for review prior to installation, preferably prior to bid.
   1. Projects located in a wind zone of 90 mph or greater.
   2. Projects where the FleeceBACK Membrane is expected to come in direct contact with petroleum based products or other chemicals.
   B. Projects where an inspection by Carlisle will be required, a shop drawing must be approved by Carlisle.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver materials to the job site in the original, unopened containers labeled with the manufacturer's name, brand name and installation instructions.

B. Job site storage temperatures in excess of 90°F may affect shelf life of curable materials (i.e., adhesive, sealants and cleaners).

C. When sealants or cleaners are exposed to lower temperatures, restore to a minimum of 60°F before use.

D. Sure-Weld FleeceBACK Membrane should be stored in its original plastic wrap or be covered to protect from moisture.

1.05 JOB CONDITIONS

A. Comply with owner requirements concerning restrictions pertaining to compaction equipment and structural load capacity. Herbicides used to treat compacted fill must be approved by the owner and applied in compliance with respective manufacturer’s instructions within applicable local codes.

B. This system shall not be applied on projects where the slope exceeds 18 inches in one horizontal foot. When the slope exceeds 5” per horizontal foot, use of an automatic welding machine may be more difficult. A hand held welder should be specified or membrane sheets be positioned perpendicular to the slope.

C. Existing erosion control membrane and anchoring devices must be removed prior to installation of new material.

D. Coordination between various trades is essential to avoid unnecessary traffic over sections of already installed membrane to prevent damage to the membrane.

1.06 WARRANTY

A 10 year Membrane Material Warranty is available for a
PART II  PRODUCTS

2.01 GENERAL

The components of this Erosion Control System are to be products of Carlisle or accepted by Carlisle as compatible. The installation, performance or integrity of products by others, when selected by the specifier and accepted as compatible by Carlisle, is not the responsibility of Carlisle and is expressly disclaimed by the Carlisle Warranty.

2.02 MEMBRANE

Sure-Weld FleeceBACK Membrane incorporates gray or tan .060” thick Sure-Weld TPO membrane laminated to a 55 mil non-woven polyester fleece-backing. The 115 mil thick membrane is available in widths of 12’ and lengths of 50’ or 100’. A selvage edge (fleece-backing is discontinued) is provided on one edge along the length of the membrane for hot air welding. Membrane is also available in white.

2.03 RELATED MATERIALS

A. Sure-Weld Reinforced and Non-Reinforced Flashing – The non-reinforced flashing is available in rolls 12” and 24” wide by 50’ long. Flashing is used for irregular details and field fabricated pipe details. The reinforced flashing is available in 4’ and 6’ by 100’ rolls and is used for flashing perimeter wall details and in conjunction with Pressure-Sensitive Cover Strip when overlaying end laps.

B. Pressure Sensitive Cover Strips - A 6” wide, 45 mil reinforced Sure-Weld TPO membrane laminated to a Pressure-Sensitive, non-staining, cream colored tape. The cover strip is designed for stripping hot air welded seams, metal edging and end laps between fleece backed membranes. The product is available in tan, gray or white and is used in conjunction with HP-250 Primer.

C. HP-250 Primer – A primer used to prepare the surface of the membrane for the application of the Pressure-Sensitive Cover Strip.

D. Sure-Weld Adhesive – A high-strength, synthetic rubber adhesive used for bonding Sure-Weld membrane to various surfaces. The adhesive is applied to both the membrane and the substrate at a coverage rate of approximately 60 square feet per gallon per finished surface (includes coverage on both surfaces).

E. CCW-2C Sealant – Used to attach the protective layer of FleeceBACK membrane over steel plates in those locations where .060” thick reinforced membrane is used as flashing. The coverage rate is approximately 20 plates per tube.

F. Cut Edge Sealant – Use to seal cut edges of Sure-Weld membrane. A coverage rate of approximately 90 linear feet per tube can be achieved when a 1/8” diameter bead is applied.

G. Weathered Membrane Cleaner – Used to prepare the membrane that has been exposed to the elements for approximately 7 days prior to hot air welding at an approximate coverage rate of 600 linear feet per gallon on a 4” wide surface.

H. Termination Bars – a 1” wide and .098” thick extruded aluminum bar pre-punched 6” on center which incorporates a sealant ledge to support Lap Sealant and provide increased stability for membrane termination.

I. Water Cut-Off Mastic – Used as a mastic to prevent moisture migration at compression terminations and beneath certain metal edgings (at a coverage rate of approximately 10’ per tube or 100’ per gallon).

J. HD 14-10 Concrete Fastener/Seam Fastening Plate – A #14 threaded fastener used in conjunction with the 2” diameter metal fastening plate to secure the FleeceBACK membrane at angle changes.

K. Erosion Control Anchors (not supplied by Carlisle) - Used to anchor the Erosion Control Membrane. The anchors are fabricated of #5 deformed reinforcing bar (ASTM A615) and welded top plate (ASTM A36). The reinforcing bar shall be 24” in length and the top plate 5” x 5” x 1/8” thick with rounded corners.

PART III  EXECUTION

3.01 GENERAL

A. When feasible, begin the application at the highest point and work to the lowest point to prevent moisture infiltration and minimize construction traffic on completed sections. This will include completion of all flashings and terminations.


3.02 SUBSTRATE PREPARATION

A. All vegetation and/or organic material shall be removed from the earth fill and eroded crevices are backfilled.

B. Fill any cracks or crevices in the earth fill with sand as required and compact earth fill in accordance with project specification to form an overburden.

C. Prior to placement of the erosion control material, the earth fill shall be treated with an approved herbicide. Comply with owner’s requirements in documenting and recording pesticide application and consult with membrane manufacturer regarding the incompatibility.

D. Along all edges of the overburden, dig a 2’ deep x 1’ wide trench below the finished grade to terminate the erosion control membrane.

E. Structural concrete walls where .060” thick reinforced Sure-Weld membrane is used as termination to erosion control membrane shall be smooth, free of fins and protrusions. Existing flashing or mechanical fasteners must be removed.

3.03 MEMBRANE INSTALLATION
Refer to the applicable Material Safety Data Sheets and Technical Data Bulletins for cautions and warnings.

A. Ensure the compacted fill/overburden is free of fins, protrusions and other sharp objects.

B. Unroll consecutive rolls of Sure-Weld FleeceBACK membrane (fleece side down), overlap approximately 11” (with selvage edge on top) and allow to relax for approximately 1/2 hour.

C. At the overlapping, along a line located 5” away from the bottom edge (where the fleece extends to the outer edge) of the membrane, install earth anchors 5’ on center in the field membrane and 3’ on center in the perimeter membranes (first membrane parallel to trench and surrounding structures).

Note: Earth anchors within the end laps shall always be positioned 3’ on center.

D. Membrane Splicing – Hot Air Welding

1. Along the length of the membrane (at selvage edges), hot air weld membrane sheets a minimum of 1-1/2” with an Automated Hot Air Welding Machine or Hot Air Hand Welder and silicone roller. Refer to the Sure-Weld FleeceBACK Adhered Roofing System Specification, Part II “Application”, for specific hot air welding procedures.

2. Membrane that has been exposed to the elements for approximately 7 days must be prepared by scrubbing the splice area with a Scotch Brite Pad and Carlisle Weathered Membrane Cleaner. Clean all residue from the prepared splice area with a HP Splice Wipe or clean natural fiber (cotton) rag prior to welding. Along the selvage edges, prime the heat welded splices with HP-250 Primer and overlay with 6” wide Pressure-Sensitive Cover Strip (centered along the splice edge).

3. At end laps, prime the overlapping area with HP-250 Primer and overlay with 6” wide Pressure-Sensitive Cover Strip (centered along the splice edge). Using a 12” wide Sure-Weld Reinforced Membrane, overlay the previously installed Pressure-Sensitive Cover Strip and heat weld a cured .060” thick membrane to the Sure-Weld FleeceBACK material on both sides and apply a bead of Cut Edge Sealant. Refer to applicable end lap detail.

D. Other Related Work

1. Walkways are required for all traffic concentration points regardless of traffic frequency. Walkways are also required if regular maintenance (once a month or more) is necessary to service equipment.

   a. Sure-Weld Heat Weldable Walkway Rolls are required when walkway pads are specified and are heat welded to the Sure-Weld Membrane.

   b. When concrete pavers are used, they shall be loose laid and installed in conjunction with a slip sheet of reinforced membrane or two layers of HP Protective Mat. Concrete pavers are not recommended when the roof slope is greater than 2” per 1 horizontal foot.

   c. Sure-Seal Interlocking Rubber Pavers, 24” X 24” X 2”, weighing approximately 6 pounds per square foot, may be loose laid directly over the membrane. Installation instruction sheets are available from Carlisle.

   Note: Walkways are considered a maintenance item and are excluded from the Carlisle Warranty.

2. Copings, counterflushing and other metal work, not supplied by Carlisle, shall be fastened to prevent metal from pulling free or buckling and sealed to prevent moisture from entering the roofing system or building.

Attach copies of the applicable Carlisle Details that pertain to the individual project to complete a bid package submittal.