HAZGARD® 635 FR

TECHNICAL DATA & SPECIFICATIONS




WE PROTECT

LAYFIELD
ENVIRONMENTAL CONTAINMENT

www.LayfieldContainment.com
www.HAZGARD635fr.com

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SECTION 1

PRODUCT OVERVIEW

HAZGARD® 635FR is a unique fire retardant secondary containment geomembrane resistant to a wide variety of fuels. HAZGARD® 635FR is designed and manufactured to meet the ULC S668 specification for secondary containment of aboveground combustible and flammable liquid tanks. The ULC S668 supersedes the old ULC ORD/C 58.9 specification which was withdrawn by ULC in 2009. This red, 35 mil (0.89mm) thick geomembrane is designed to be a robust, flexible, fire retardant secondary containment material. HAZGARD® 635FR is ideal for making factory fabricated liners that are custom sized to fit your containment system and can be folded and shipped to site in big panels.

HAZGARD® 635FR is an excellent lining material for the secondary containment of flammable and combustible liquids, including gasolines and alcohol-blended gasolines, diesels and biodiesel-blended diesels, jet fuels, oils and lubricants. HAZGARD® 635FR is resistant to a wide range of chemicals including hydrocarbons, solvents, acids, bases, and salts. HAZGARD® 635FR is UV stable with added fire retardants and may be used exposed when appropriate in certain applications and jurisdictions. HAZGARD® 635FR comes in a special red color that is highly visible to help identify the geomembrane in both buried and exposed applications.

This booklet summarizes our extensive performance testing completed on this material.

SECTION 2

Table 1 Material Characteristics & Physical Properties

HAZGARD® 635FR Material Properties		
Property	**Standard**	**Specification**
Thickness (min)	ASTM D5199	35 mil 0.88 mm
Tensile Strength (Marv)	ATSM D751 Grab Method	300 lbs 1330 N
Tensile Strength (Marv)	ASTM D638 Strip Method	130 lbs/in 22.7 N/mm
Elongation	ASTM D751 Grab Method	700%
Puncture Strength	ASTM D4833	49 lbs 218 N
28 Day Permeance to Test Fluids	ULC S668	<10 g/m²/hr
30 Day Compatibility to Test Fluids	ULC S668	<10% Wt Change
30 Day Soil Burial	ULC S668	Pass
Low Temperature Bend	ASTM D1790	-40˚ F -40˚ C
CERTIFICATION	Layfield can provide a letter sealed by a P.Eng stating that the geomembrane meets our published material properties and that it comforms to the ULC S668 standard	
***Test Fluids include 16 different flammable, combustible and oxygenated liquids as defined by ULC S668**		
HAZGARD® Minimum Shop Seam Strengths		
ULC S668 Seam Strength Requirement	D7749 Grab Method	112 lbs 500 N
Heat Bonded Seam Strength	D6392 25.4 mm (1") Strip	55 lbs 9.6 N/mm
Heat Bonded Peel Adhesion Strength	D6392 25.4 mm (1") Strip	45 lbs 7.9 N/mm
HAZGARD® Minimum Field Seam Strengths		
ULC S668 Seam Strength Requirement	D7747 Grab Method	112 lbs 500 N
Heat Bonded Seam Strength	D6392 25.4 mm (1") Strip	55 lbs 9.6 N/mm
Heat Bonded Adhesion Strength	D6392 25.4 mm (1") Strip	45 lbs 7.9 N/mm

SECTION 3

PERFORMANCE PROPERTIES

Chemical Resistance

HAZGARD® 635FR has been tested for both chemical compatibility and permeation performance to a broad range of chemicals required by ULC S668. Chemical testing included flammable liquids such as gasoline, gasoline mixed with alcohols, methanol and ethanol. The testing also included combustible liquids such as diesel fuels. Additional tests have shown excellent resistance to biodiesel and biodiesel blends and heavier hydrocarbons such as lubricants. HAZGARD® 635FR is made from polymer resins that are naturally resistant to acids and bases.
Samples are available for immersion testing in cases where the chemical resistance of HAZGARD® 635FR to the liquid to be contained is not known.. Your Layfield representative can assist you in performing a chemical test.

Vapour Transmission Test

HAZGARD® 635FR exhibits very low vapour transmission rates (VTR) when tested with the fuels and chemicals listed in **Table 2**. The testing was performed using ASTM D814, Standard Test Method for vapour transmission of volatile liquids. Layfield carried out the tests using sealing cups to ensure no leakage of solvent vapours occured during testing. The polymer structure of HAZGARD® 635FR is designed to limit the diffusion of vapours through the material. HAZGARD® 635FR comfortably met the ULC S668 criteria of VTR equal or less than 20 g/h·m^2. In this test, the samples of HAZGARD® 635FR were exposed for 28 days. The VTR was calculated after 5th, 8th and 28th day of the test. A requirement of this test is that the VTR generated between day 5 and day 28 shall not be greater than the VTR determined between day 5 and day 8.

Table 2. Vapour Transmission Tests

Chemical Value	Requirement	Test Value
Fuel C[1]	20 g/(h•m^2)	7.2 g/(h·m^2)
Fuel H[2]	20 g/(h•m^2)	5.3 g/(h·m^2)
Ethanol	20 g/(h•m^2)	<0.1 g/(h·m^2)
Methanol	20 g/(h•m^2)	<0.1 g/(h·m^2)
IRM 903[3]	20 g/(h•m^2)	<0.1 g/(h·m^2)
Petroleum Diesel Blend[4]	20 g/(h•m^2)	<0.4 g/(h·m^2)
Biodiesel (Canola Source)	20 g/(h•m^2)	<0.1 g/(h·m^2)
Biodiesel (Tallow Source)	20 g/(h•m^2)	<0.1 g/(h·m^2)
B20[5] (Canola Source)	20 g/(h•m^2)	0.3 g/(h·m^2)
B20[5] (Tallow Source)	20 g/(h•m^2)	0.5 g/(h·m^2)

[1] 50% Toluene and 50% Iso-octane
[2] 85% Fuel C and 15% Ethanol
[3] A standard test oil
[4] Blend of diesel from three commercial stations
[5] Refers to 20% biodiesel blend

SECTION 3

PERFORMANCE PROPERTIES

Compatibility Testing

Chemical compatibility tests were performed to determine the suitability of HAZGARD® 635FR liner to flammable and combustible liquids. In this method, the samples were exposed to at least 8 chemicals and then checked for changes in weight, volume and tensile strength. The main difficulty in the compatibility test is that the conditioning time is only 2 hours after immersion (normal test conditioning is 48 hours). This tends to inflate weight change results and makes this test very challenging. Table 3 presents the compatibility test results

Table 3. Compatibility Testing

Chemical	Result
Fuel C[1]	Pass
Fuel H[2]	Pass
Ethanol	Pass
Methanol	Pass
IRM 903[3]	Pass
Petroleum Diesel Blend[4]	Pass
Biodiesel (Canola Source)	Pass
Biodiesel (Tallow Source)	Pass
B205 (Mixed source)[6]	Pass
B20[5] (Tallow Source)	Pass
pH 10 solution	Pass
pH 3 solution	Pass
Salt solution (saturated)	Pass

[1] 50% Toluene and 50% Iso-octane
[2] 85% Fuel C and 15% Ethanol
[3] A standard test oil
[4] Blend of diesel from three commercial stations
[5] Refers to 20% biodiesel blend
[6] Tallow and Canola source at 10% each

SECTION 3

PERFORMANCE PROPERTIES

Physical Tests

The S668 physical tests include material strength, seam strengths (in peel and shear), tear strength, burst strength, cold temperature crack resistance and flammability. The flammability test in the S668 is not a common test. A special apparatus was built to perform this test.

Seam Strength

The seams provide a permanent bond between different panels of the material when seamed using thermal techniques. It is important to test these seams in order to ensure their integrity in critical applications. Both seam and peel strengths were determined, the results are tabulated in the material properties page **(Table 3)**.

Tear Strength

The sample is required to be immersed for 30 days prior to being subjected to the tear test. The specification requires that the specimen shall retain 90% of its "as received" tear strength after exposure to fuels, as specified in **Table 4**.

Burst Strength

Burst tests measure the pressure required to burst a material hydraulically using a Mullen burst type tester.

Cold Crack Resistance

The test covers the determination of resistance of coated fabrics to cracking when exposed to low temperatures and the subsequent ability to maintain hydrostatic resistance. To withstand a wide temperature range, Layfield tested HAZGARD® 635FR between 40±2°C and -40±2°C. In this test, the specimens are conditioned in the low-temperature chamber at the required temperature. While still in the chamber, each specimen is creased by folding (specimens are folded 180° in the center in both directions respectively). The specimen is then removed from the chamber and visually examined for signs of cracking or flaking.

SECTION 3

PERFORMANCE PROPERTIES

Flammability

In the flammability tests, the specimens are exposed to a flame for a total of 12 seconds. To meet the requirement, the specimen shall cease burning 5 seconds after the flame source is removed. No dripping of molten polymer is accepted during the duration of the test.

Table 4. Physical Test Results

Test Description	Requirement	Test Value
Material Grab Strength	500 N	1372 N
Seam Strength Grab	500 N	1233 N
Seam Strength Peel	2.5 N/mm	9.8 N/mm
Tear Strength Tests after 30 days in Fuel C	90% retained	91% retained
Hydrostatic Burst Strength	690 kPa	1240 kPa
Cold Temp Crack	-40°C	Pass
Flammability	<5 seconds	0 seconds

SECTION 3

PERFORMANCE PROPERTIES

Aging tests

The aging tests included heat aging, accelerated weathering, and soil burial. See **Table 5**. In all three cases, the material properties after exposure are compared to the starting properties and the changes are are noted.

Weathering

The accelerated weathering test exposes the specimens to UV light over a period of 3,000 hours or 125 days. HAZGARD® 635FR meets the requirements of the ageing tests.

Soil Burial

The soil burial test exposes the sample to a biologically active soil mixture for a period of 30 days. This soil mixture has caused problems for certain materials in the past.

Heat Aging

This test method is used to estimate the relative heat deterioration resistance of liner materials. In this test, specimens are placed in a convection oven for 60 days at 80±2°C (172.4 - 179.6°F). The specimens are conditioned for 24 hours before testing for retained tensile strength.

Table 5. Ageing Test Results

Test Description	Requirement	Test Value
Weathering[1]	70% Retained	93%
Heat Aging[2]	50% Retained	98%
Soil Burial	70% Retained	98%

1 10 hour UV cycle at 60C followed by 2 hour condensation cycle

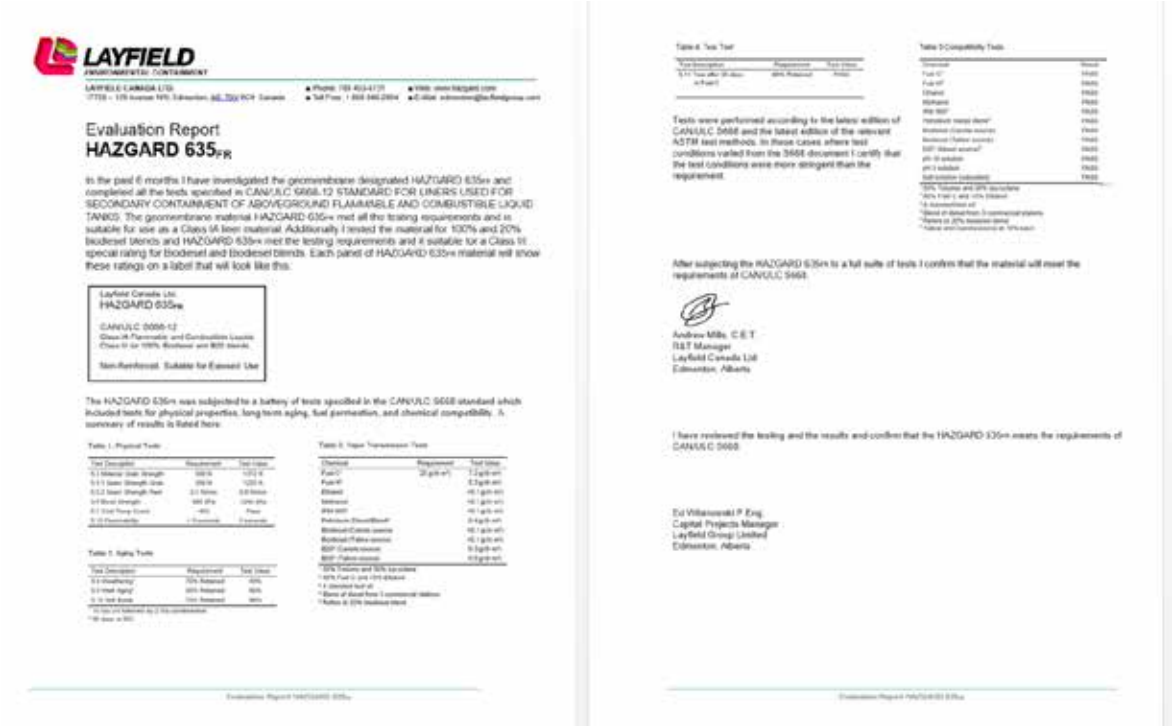
2 90 days at 85C

SECTION 4

S668 COMPLIANCE

All aboveground tanks in a secondary containment application that contain flammable and combustible fluids are required to meet the ULC S668 standard. At Layfield, we certify our HAZGARD® 635FR to the ULC S668 standard and provide an evaluation report that is signed by our Research and Technology Manager and certified by a Professional Engineer.

- A sample of evaluation report is shown below:



LAYFIELD
ENVIRONMENTAL CONTAINMENT

Evaluation Report
HAZGARD 635FR

In the past 6 months I have investigated the geomembrane designated HAZGARD 635m and completed all the tests specified in CAN/ULC S668-12 STANDARD FOR LINERS USED FOR SECONDARY CONTAINMENT OF ABOVEGROUND FLAMMABLE AND COMBUSTIBLE LIQUID TANKS. The geomembrane material HAZGARD 635m met all the testing requirements and is suitable for use as a Class IA liner material. Additionally I tested the material for 100% and 20% biodiesel blends and HAZGARD 635m met the testing requirements and it suitable for a Class III special rating for biodiesel and biodiesel blends. Each panel of HAZGARD 635m material will know these ratings on a label that will look like this:

Layfield Canada Ltd.
HAZGARD 635m

CAN/ULC S668-12
Class IA Flammable and Combustible Liquids
Class III for 100% Biodiesel and B20 blends

Non-Reinforced, Suitable for Exposed Use

The HAZGARD 635m was subjected to a battery of tests specified in the CAN/ULC S668 standard which included tests for physical properties, long term aging, fuel permeation, and chemical compatibility. A summary of results is listed here:

Table 1 - Physical Tests

Test Description	Requirement	Test Value
5.1 Minimum Grab Strength	556 N	1372 N
5.1.1 Seam Strength Grab	556 N	1232 N
5.1.2 Seam Strength Peel	311 N/mm	0.8 N/mm
5.2 Burst Strength	965 kPa	1241 kPa
5.3 Cold Temp Crack	<-40C	Pass
5.4 Permeability	< Permeate	< Permeate

Table 2 - Aging Tests

Test Description	Requirement	Test Value
5.1 Weathering	70% Retained	90%
5.2 Heat Aging	80% Retained	90%
5.3 Hot Acid	70% Retained	98%

Table 3 - Vapor Transmission Tests

Chemical	Requirement	Test Value
Fuel C	20 g/m²-d*1	7.2 g/m²-d*1
Fuel B*		5.3 g/m²-d*1
Ethanol		<5.1 g/m²-d*1
Methanol		<5.1 g/m²-d*1
MTBE		<5.1 g/m²-d*1
Petroleum Diesel/Blend*		2.4 g/m²-d*1
Biodiesel Canola source		<5.1 g/m²-d*1
Biodiesel Palma source		<5.1 g/m²-d*1
B20* Canola source		5.3 g/m²-d*1
B20* Palma source		4.5 g/m²-d*1

*20% Toluene and 80% Iso-octane
*1 40% Fuel C and 10% Ethanol
*2 A standard fuel of:
*3 Blend of diesel from 3 commercial stations
*4 Refers to 20% biodiesel blend

Tests were performed according to the latest edition of CAN/ULC S668 and the latest edition of the relevant ASTM test methods. In those cases where test conditions varied from the S668 document I certify that the test conditions were more stringent than the requirement.

Table 4 - Test Test

Test Description	Requirement	Test Value
5.11 Tear after 30 days in Fuel C	80% Retained	Pass

Table 5 Compatibility Tests

Chemical	Result
Fuel C*	PASS
Fuel B*	PASS
Ethanol	PASS
Methanol	PASS
MTBE*	PASS
Petroleum Diesel Blend*	PASS
Biodiesel Canola source	PASS
Biodiesel Palma source	PASS
B20* Blend source*	PASS
pH > 9 solution	PASS
pH < 3 solution	PASS
Salt solution (saturated)	PASS

*20% Toluene and 80% Iso-octane
*40% Fuel C and 10% Ethanol
*A standard fuel of:
*Blend of diesel from 3 commercial stations
*Refers to 20% biodiesel blend
*Tested and maintained at 10% burst

After subjecting the HAZGARD 635m to a full suite of tests I confirm that the material will meet the requirements of CAN/ULC S668.

Andrew Mills, C.E.T
R&T Manager
Layfield Canada Ltd
Edmonton, Alberta

I have reviewed the testing and the results and confirm that the HAZGARD 635m meets the requirements of CAN/ULC S668.

Ed Villanueva P.Eng
Capital Projects Manager
Layfield Group Limited
Edmonton, Alberta

Product Identifier

HAZGARD® 635FR is marked according to the requirements of the S668 standard and includes the following information: name of the manufacturer, product identification, standard and class(es), form of the liner and suitability for exposed use. That marking will appear as a label or direct printing on the liner as shown below:

Layfield Canada Ltd.
HAZGARD® 635FR

CAN/ULC S668-12
Class IA Flammable and Combustible Liquids
Class III for 100% Biodiesel and B20 blends

Non-Reinforced, Suitable for Exposed Use (E)

SECTION 4

S668 COMPLIANCE

A note to specifiers and owner's representatives:

As per the ULC S668, secondary containment liners are not intended for long-term or permanent storage of product spills or leakage. Adequate means of monitoring and cleanup is required along with proper use and installation in accordance with codes and regulations of the authority having jurisdiction. In case of product spills or leakage, the secondary containment liners shall be re-evaluated according to the requirements of the authority having jurisdiction.

SECTION 5

BACKFILLING GEOMEMBRANES

Backfilling

Almost all liner materials can benefit from using a backfill cover. Properly designed backfill systems can extend the life of a geomembrane liner to the maximum extent possible. Backfill can often be selected from locally available fill materials or may have to be hauled from a nearby quarry. Suitable backfill materials include processed or natural non-cohesive soils, such as a gravelly sand, screened sand and pea gravel. Well graded cohesive soils, such as clayey-silt or silty-clay are also suitable backfill materials. The minimum backfill required over a liner depends on several factors such as the type of equipment used to place the backfill, the friction properties between the membrane and soil, etc. Typically, a minimum cover of 18" (450 mm) is needed over a geomembrane. Placement of backfill on a steep slope can be challenging and may require the use of other geosynthetic materials to confine the backfill and stabilize the soil mass on top of the geomembrane. Please refer to our backfill design technical note in our website (www.LayfieldContainment.com) under the Resources section. Layfield can also help reduce backfill thickness by incorporating innovative geosynthetic solutions, please contact your Layfield representative for more information.

SECTION 6

CSI SPECIFICATION

Summary - Construction Specification Institute (CSI) specification:

Part 1 General

1.1 SECTION INCLUDES

.1 HAZGARD® 635 FR geomembrane

1.2 PERFORMANCE REQUIREMENTS

.1 Geomembrane:

- .1 Contain the following chemical(s):
  - .1 Flammable and Combustible Liquids.
- .2 Remain flexible throughout service life.
- .3 Show good resistance to UV degradation.
- .4 Shall be tested in accordance with ULC S-668 requirement for Secondary Containment of Liners for Underground and Aboveground Flammable and Combustible Liquid Tanks.

1.3 SUBMITTALS

- .1 Section 01 33 00; Submission Procedures
- .2 Product Data:
  - .1 Provide specification sheets for geomembrane.
  - .2 Provide mill test reports for geomembrane roll stock used to make liner.
- .3 Provide shop test reports for each fabricated panel produced.
- .4 Provide field test reports for all welds completed in the field.

1.4 QUALITY ASSURANCE

- .1 Geomembrane manufacturer to be ISO 9001 registered.
- .2 Fabricator to be ISO 9001 registered or follow ISO 9001 compliant procedures.
- .3 Installer to follow documented installation plan and work procedures.

1.5 WARRANTY

- .1 Section 01 78 10: Warranties.
- .2 Provide a manufacturer's pro-rated weathering warranty for [HAZGARD® 635 FR Ten (10) years]

SECTION 6

CSI SPECIFICATION

Part 2 Products

2.1 MANUFACTURERS

.1 Layfield Canada Ltd.

2.2 SPECIFICATION

.1 See section on material properties **(Table 1).**

2.3 FABRICATOR

.1 Geomembrane fabricator shall have at least two years' experience in the factory fabrication of geomembranes. The Geomembrane fabricator shall have fabricated at least 500,000 m2 (5,000,000 ft2) of geomembrane during the last two years.

.2 Geomembrane fabricator shall be certified by the geomembrane manufacturer and follow manufacturer's fabrication specifications.

2.4 FABRICATION

.1 Set Up

.1 Carefully transfer rolls of geomembrane from storage to unwinding rack.

.2 The floor or table must be clean, dry, and free of foreign objects that could damage the liner.

SECTION 6

CSI SPECIFICATION

.3 Pull panels to specified length, after double-checking dimensions on the work order.
.4 Ensure seaming equipment is in good repair and functioning properly. Ensure equipment is adjusted to the material.
.5 Follow documented welding procedures.

.2 Qualification Seam
.1 A qualification seam will be run prior to any fabrication.
.2 The qualification seam must be run using the same material and equipment that will be used for fabrication.
.3 Machine conditions and operator used for fabrication must be the same as those used for the qualification weld.
.4 Qualification seam must be tested in shear and peel and meet the specified requirements for the material as stated in the materials section.
.5 A qualification seam must be rerun whenever the operator is changed, equipment adjusted, shift changed, or if equipment is idle for more than 2 hours.

.3 Fabrication Seams
.1 Fabrication seams must meet the specified requirements in peel and shear for the material.
.2 Fabrication seams will be destructively tested in shear and peel according to ASTM D6392.
.1 Test one specimen each in peel and shear on the first and last welded panel, and,
.2 Test one specimen each in peel and shear for every 300 lineal meters (1000 lineal feet) of welding
.3 A record of the seam test results is maintained on the Shop QC report.
.4 The seaming process must be constantly supervised by the equipment operator. 100 % of the fabrication seams must be visually inspected during seaming.

.4 Protection from Damage
.1 Protect completed panels from damage.
.2 Handle carefully to avoid damaging the liner.

.5 Packaging
.1 Each panel will be accordion folded in one direction, and rolled or folded in the other direction.
.2 Wrap completed panels in a weather resistant, opaque cover material.
.3 Hold wrapper securely in place using UV resistant tape or other secure method.
.4 Label the packaged liner to clearly show:
.1 Material type
.2 Dimensions
.3 Stock code

CSI SPECIFICATION

.4 Sales order number
.5 QC number
.6 Panel number
.7 Unfolding and deployment directions

2.5 DELIVERY STORAGE AND PROTECTION

.1 Shipping
- .1 Completed panels will be placed on clean, serviceable pallets, free from exposed nails or other obstructions.
- .2 A layer of geomembrane, geotextile, or wood will be placed on all pallets to protect the panel from damage.
- .3 Secure panels to the pallet using metal or plastic bands. Use a layer of geomembrane between the packaged liner and the band to prevent damage to the liner as the band is tightened.
- .4 The packaged liner must not extend beyond the outer edges of the pallet. Use larger pallets or a layer of plywood to extend the pallet edges to match the liner.
- .5 Carefully handle and place on the truck to avoid damage to the liner.
- .6 [Do not stack panels] [Panels may be stacked not more than two high].

.2 Delivery
- .1 All panels will be inspected for damage on delivery.
- .2 Use suitable unloading equipment to handle panels. Do not drag, slide, or drop panels during unloading.
- .3 Place panels in a prepared area away from soft ground, standing water, or other deleterious surfaces.
- .4 Replace any pallets that may become damaged during shipping or handling.
- .5 Store liner panels in a secure area protected from extremes of heat or cold.
- .6 Protect panels from damage prior to use.

2.6 ACCESSORIES

.1 Welding Rod will be manufactured from the same formulation as the geomembrane.
.2 Preformed Pipe Boots will be vacuum formed from thicker sheet material manufactured from the same formulation as the geomembrane.

Part 3 Execution

3.1 INSTALLER

.1 The Geomembrane Installer shall have at least three years of experience in the installation of the geomembrane. The Geomembrane Installer shall have installed at least 500,000 m^2 (5,382,000 ft^2) geomembrane during the last three years.
.2 Geomembrane Installer shall be certified by the geomembrane manufacturer and follow manufacturer's installation specifications.

SECTION 6

CSI SPECIFICATION

3.2 PREPARATION

.1 Ensure subgrade is compacted and surface finished to not impair installed membrane.

.2 Subgrade to provide firm, unyielding surface with no sharp changes or abrupt breaks in grade. A smooth drum rolled surface is preferable.

.3 Ensure surfaces to be lined are smooth, free of foreign and organic material, sharp objects, or debris of any kind.

.4 If a suitable sub-grade is not available then a cushion layer of 100mm (4 inches) of clean sand] [LP8 non-woven geotextile] shall be placed prior to liner placement.

.5 Excavate anchor trench to line, grade, and width indicated on drawings, prior to liner placement. Provide slightly rounded corners in the trench to avoid sharp bends in the geomembrane.

.6 Prepare mechanical attachments according to ASTM D6497 Standard Guide for Mechanical Attachment of Geomembrane to Penetrations or Structures.

.7 All concrete surfaces to which the liner will attach shall have “smooth trowel” finish. All the corners should have radius to a minimum 25mm (1 inch) as per the drawing.

.8 Compaction at pipe penetrations and areas of mechanical attachment will be inspected carefully as these are areas where differential settlement can occur.

.9 A certificate of subgrade acceptance will be prepared by the liner installation contractor prior to liner installation.

CSI SPECIFICATION

3.3 INSTALLATION

.1 Installation of the geomembrane shall be performed in a logical sequence.

.2 Place panels according to the drawings, the panel layout, and the label on each panel.

.3 Sufficient thermal slack shall be incorporated during placement to ensure that harmful stresses do not occur in service.

.4 Weather Conditions at Time of Installation:

- .1 Site welding may proceed at any temperature providing a suitable qualification weld can be prepared at site conditions using the operator, equipment and materials intended for the project.
- .2 Installation of membrane in winds above 20 km/h (12 mph) can proceed only if the installer can demonstrate that the liner will not be at risk of damage.
- .3 Do not install membrane during precipitation or in the presence of excessive moisture.
- .4 Do not install in weather conditions that may be detrimental to the function of the membrane.

.5 Ensure personnel working on geomembrane do not use damaging footwear.

.6 Protect completed panels from damage; handle carefully to avoid damaging the liner.

.7 Equipment and methods used to unroll liner panels should not damage the prepared subgrade.

.8 Ballast used to prevent uplift by wind must not damage the geomembrane. A continuous load is recommended along the edges of panels to eliminate the risk of wind uplift.

.9 Qualification Seams

- .1 A qualification seam will be run prior to any field seams.
- .2 A qualification seam is made with separate pieces of geomembrane using the same material and equipment that will be used for production welding.
- .3 Machine conditions and operator used for welding must be the same as those used for the qualification weld.
- .4 Qualification seam must be tested in shear and peel and meet the specified requirements for the material as stated in the materials section.
- .5 A qualification seam must be rerun whenever the operator is changed, the equipment adjusted, or at least every 4 hours.

.10 Field Seams

.1 Field seams will be sampled for testing in a way that does not compromise the installed liner.

.1 One sample to be tested for every 150m (500 ft) of field seam.

.2 Test samples are to be removed from the ends of seams, from the anchor trench, or other location that does not introduce a defect into the liner.

CSI SPECIFICATION

.3 Samples to be approximately (100 mm (4 inches) long to permit testing of one shear and two peel specimens (ASTM D6392).
.4 Test samples immediately after seaming.
.5 Record date, location and pass/fail description.
.2 Field seams must meet the specified requirements in peel and shear for the material.
.3 A written record will be maintained for all field seam tests.
.4 All completed field seams will be 100% non-destructively tested using an air lance test (ASTM D4437 method 7.2).

3.4 TOLERANCES

.1 Seam Tests:
.1 Follow the procedure in ASTM D6392
.2 Test three specimens per sampling point, one in shear and two in peel.
.1 All specimens to meet seam strength requirements.
.3 Procedures for Destructive Test Failure:
.1 Cut out seam and re-weld; or,
.2 Retrace welding path to 3 m (10 feet) from location of failed test. Take sample for additional test. If passed, cap strip or extrusion weld between failed location and original failed location.

3.5 REPAIR

.1 Inspect seams and non-seam areas for defects, holes, blisters, undispersed raw materials.
.2 Identify any sign of foreign matter contamination.
.3 Repair all through-thickness defects.
.4 Defective Seams: Cap strip or replace.
.5 Small Holes: Repair by extrusion welding using a bead of extruded material over hole. Patch if hole is larger than 6 mm (1/4 inch).
.6 Tears: Patch and seal round sharp ends of tears on slope or stressed area prior to patching.
.7 Repair blisters, large cuts and undispersed raw materials with patch.
.8 Secure Patches by Extrusion Welding or Hot Air Welding:
.1 Extrusion welding.
.1 Clean area to be patched.
.2 Tack patch in place with hot air welding or with double sided tape.
.3 Prepare patch area by roughening with a wire brush.
.4 Extrude all the way around patch.
.5 More than one extrusion bead can be laid side-by-side on HAZGARD® 635 FR materials. A maximum of three extrusion beads can be laid side-by side on HAZGARD® 635 FR.

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CSI SPECIFICATION

.2 Hot Air Welding
- .1 Hand hot air welding is permitted for patching Enviro Liner.
- .2 Clean area to be patched.
- .3 Hand weld the patch with a hot air gun and suitable roller.

.9 Patches: Round or oval of same geomembrane. Extend minimum 75 mm (3 inches) beyond the edge of the defect.

.10 Verification of Repairs: All repairs to be non-destructively tested using
- .1 Air Lance Test, ASTM D4437 Method 7.2
- .2 Vacuum Box Test ASTM D5641

.11 Redo failed repairs and retest.

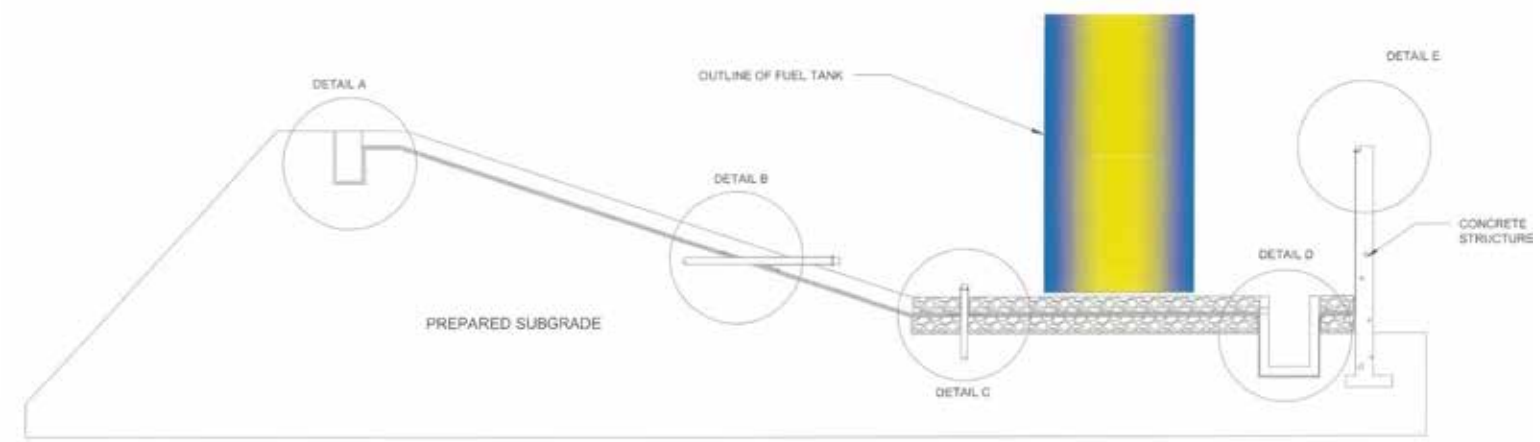
.12 Keep records of all repairs and the results of repair testing.

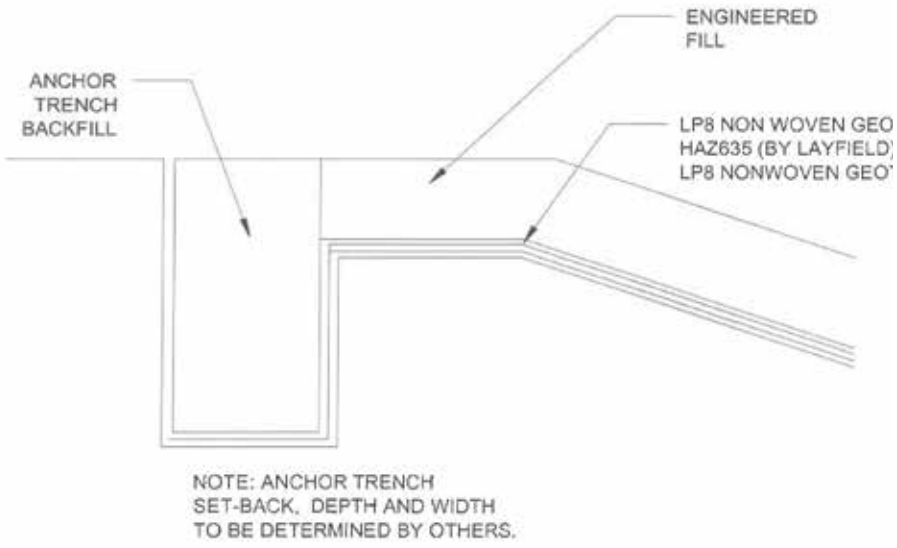
END OF SECTION

SECTION 7

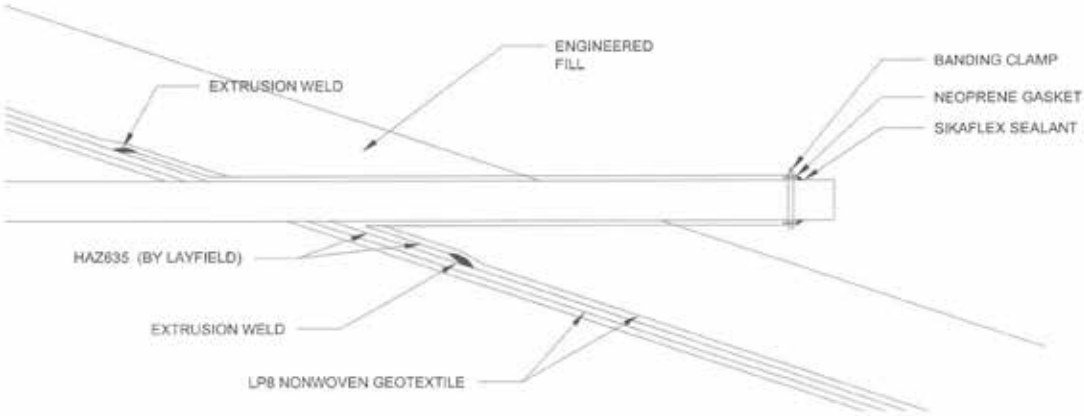
TYPICAL DRAWINGS

HAZGARD® 635FR INSTALLATION TYPICAL DETAILS





TYPICAL ANCHOR TRENCH – DETAIL A

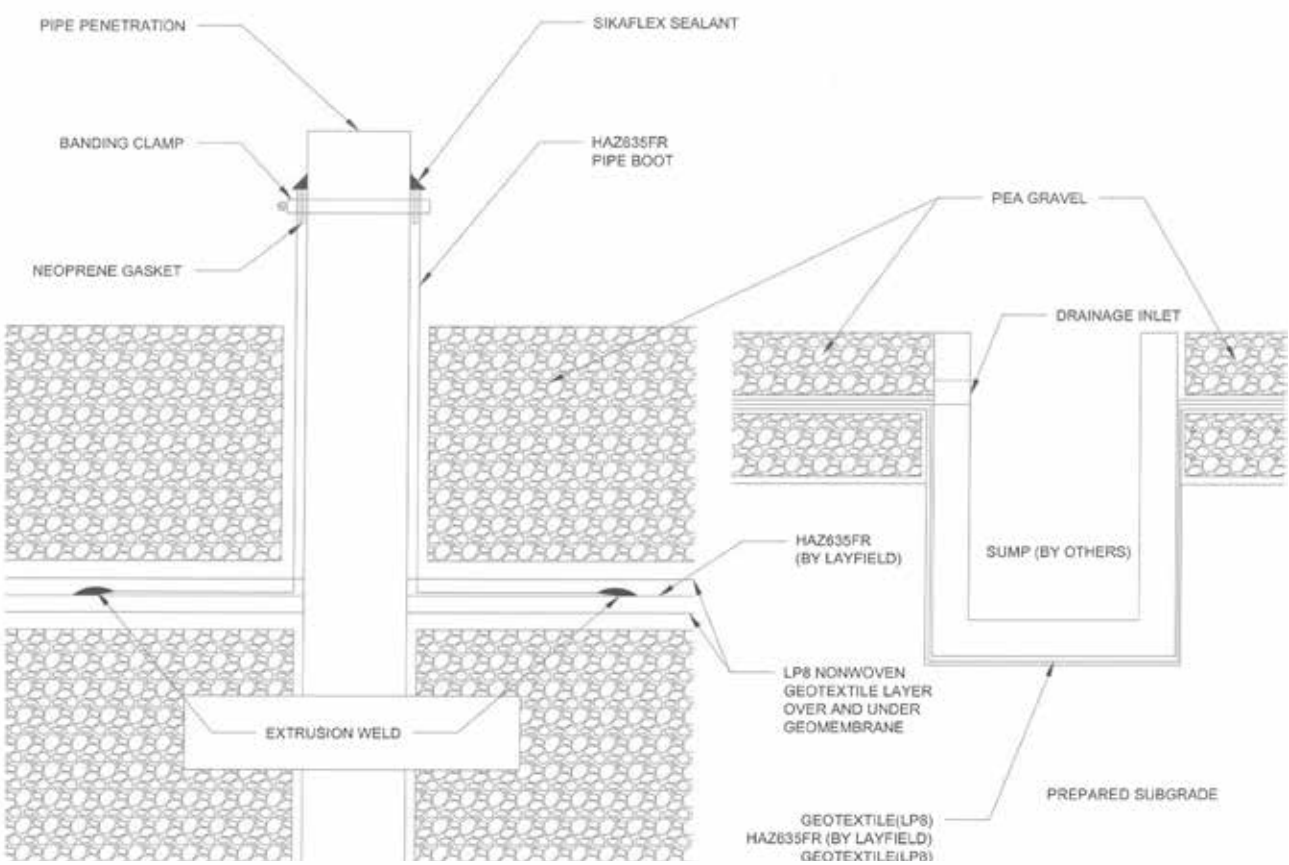


TYPICAL SLOPE PIPE PENETRATION – B

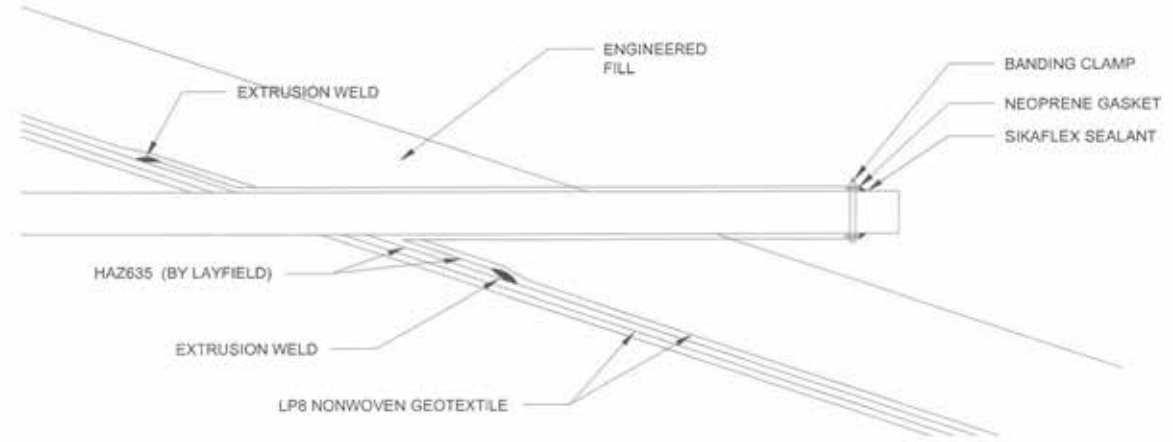
SECTION 7

TYPICAL DRAWINGS

TYPICAL VERTICAL PIPE PENETRATION – DETAIL C



TYPICAL SUMP DETAIL – DETAIL D

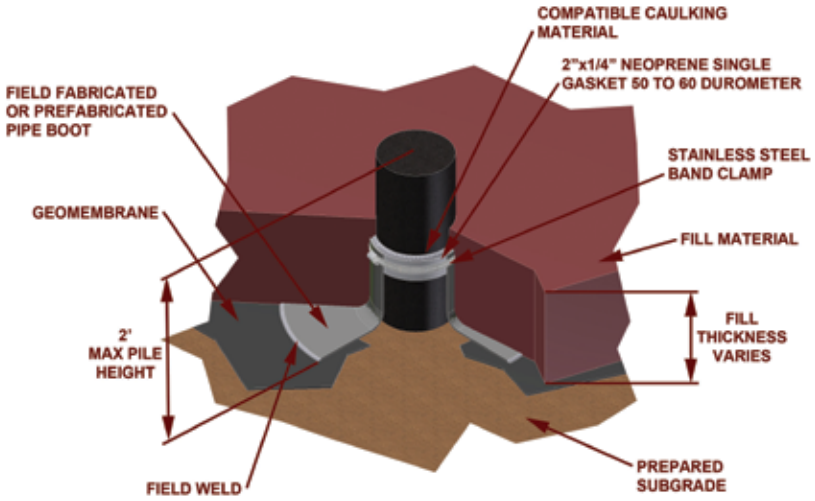


TYPICAL MECHANICAL ATTACHMENT DETAIL – DETAIL E

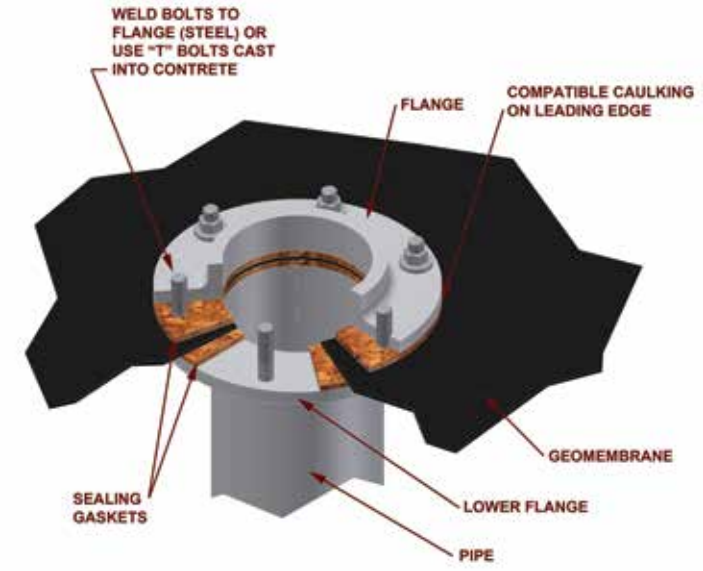
SECTION 7

TYPICAL DRAWINGS

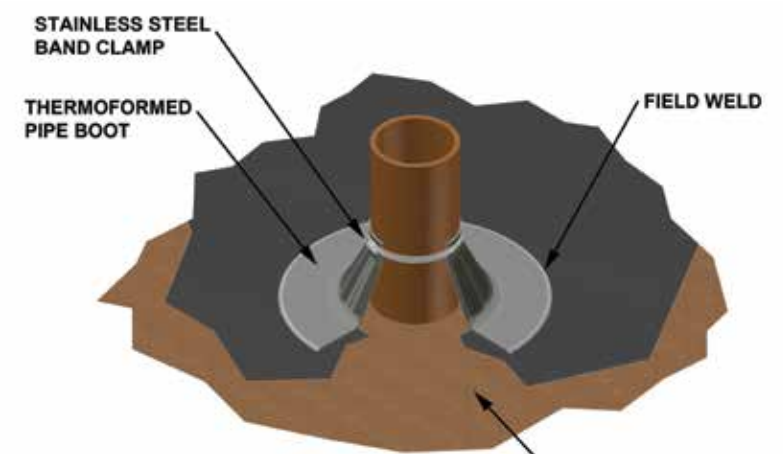
PILING SUPPORT



PIPE FLANGE



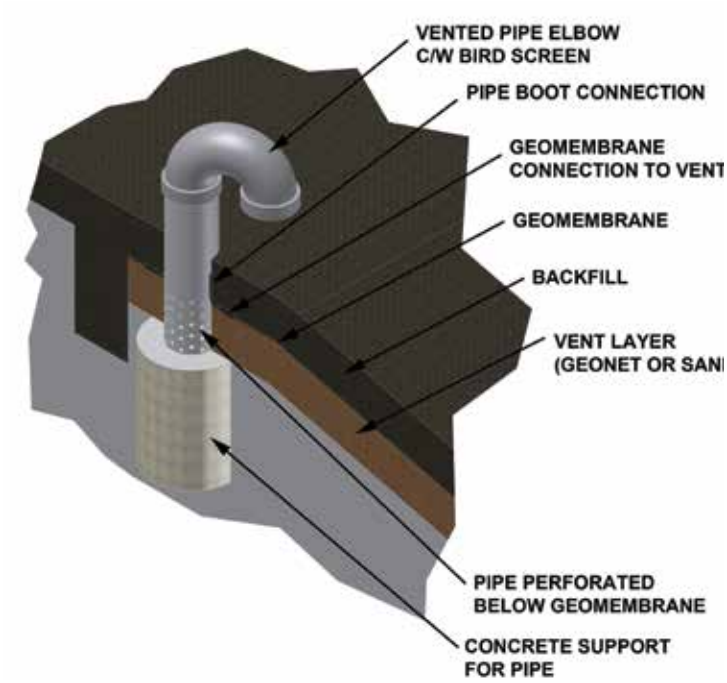
THERMOFORMED BOOT



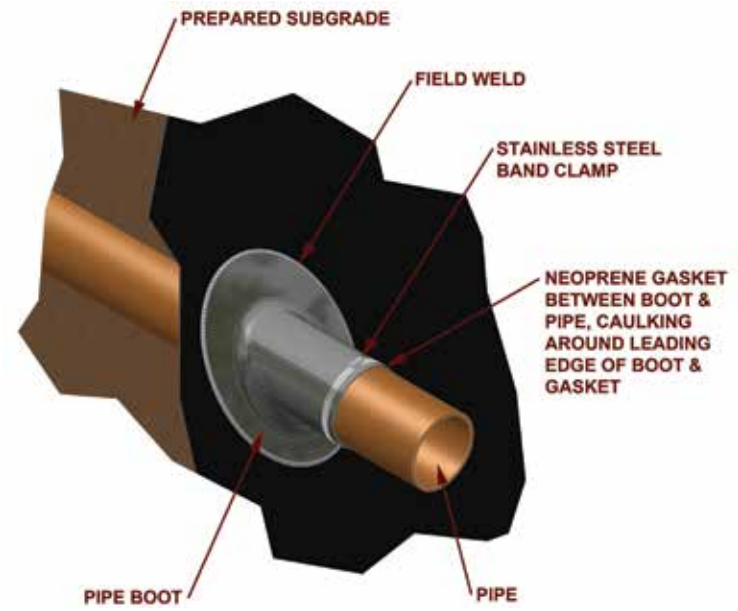
SECTION 7

TYPICAL DRAWINGS

VENT DETAIL



PIPE BOOT



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