

VERMONT CONSTRUCTION SPECIFICATION

97 – HDPE and LLDPE Liner

1. Scope

The work shall consist of furnishing and installing a High Density Polyethylene (HDPE) or Low Linear Density Polyethylene (LLDPE) liner and the necessary mechanical attachments as shown in the drawings or as specified herein. Unless otherwise specified, complete HDPE and LLDPE liner systems constructed in strict accordance to manufacturer's specifications and recommendations will be accepted as an equivalent substitute to this specification.

2. Material

The liner, welding rod, gaskets, metal battens, clamps, embed channel, and sealant shall conform to the requirements shown on the drawings.

Subgrade soils and their surface conditions shall conform to the requirements in this specification and as shown in the drawings.

Cover soils, if applicable, shall conform to this specification and as shown on the drawings.

A. Gaskets, Metal Battens, Clamps, Embedded Channels, and Sealants

Gasket material shall be neoprene, closed cell medium, 0.25 inch thick, with adhesive on one side, or other gasket material as approved by the liner manufacturer. Metal battens shall be 0.25 inch thick by 2 inches wide stainless steel. Clamps shall be 0.5-inch-wide stainless steel. Embedded channel shall have the same properties as the liner. Sealant shall be General Electric Silicone, RTV 103, or equivalent.

B. HDPE and LLDPE liner properties

The HDPE or LLDPE liner shall be manufactured from virgin polymer material and shall have a nominal thickness of 30 mils, 40 mils, or 60 mils as specified. The liner shall be manufactured to be suitable for use in either exposed or buried conditions. It shall conform to the requirements of this specification as shown in tables 1 through 4. It shall also meet the requirements shown on the drawings.

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Table 1 – Requirements for Smooth HDPE Liner

<u>Property</u>	<u>Test Method</u>	Requirements (Nominal Thickness) *		
		<u>30 Mil</u>	<u>40 Mil</u>	<u>60 Mil</u>
Density, g/cc	ASTM D1505	0.940	0.940	0.940
Tensile Properties	ASTM D638 (Type IV at 2 in/min)			
Yield Stress, lb/in		63	84	126
Break Stress, lb/in		114	152	228
Yield Elongation, %		12	12	12
Break Elongation, %		560	560	560
Tear Resistance, lb	ASTM D1004	21	28	42
Puncture Resistance, lb	ASTM D4833	54	72	108
Carbon Black Content, %	ASTM D1603	2-3	2-3	2-3
Carbon Black Dispersion	ASTM D5596	Cat 1-2	Cat 1-2	Cat 1-2
Seam Properties	ASTM D4437 (1 inch wide at 2 in/min)			
Shear Strength, lb/in		60	80	120
Peel Strength, lb/in **		39/FTB	52/FTB	78/FTB

Table 2 – Requirements for Textured HDPE Liner

<u>Property</u>	<u>Test Method</u>	Requirements (Nominal Thickness) *		
		<u>30 Mil</u>	<u>40 Mil</u>	<u>60 Mil</u>
Density, g/cc	ASTM D1505	0.940	0.940	0.940
Tensile Properties	ASTM D638 (Type IV at 2 in/min)			
Yield Stress, lb/in		63	84	126
Break Stress, lb/in		45	60	90
Yield Elongation, %		12	12	12
Break Elongation, %		100	100	100
Tear Resistance, lb	ASTM D1004	21	28	42
Puncture Resistance, lb	ASTM D4833	45	60	90
Carbon Black Content, %	ASTM D1603	2-3	2-3	2-3
Carbon Black Dispersion	ASTM D5596	Cat 1-2	Cat 1-2	Cat 1-2
Seam Properties	ASTM D4437 (1 inch wide at 2 in/min)			
Shear Strength, lb/in		60	80	120
Peel Strength, lb/in **		39/FTB	52/FTB	78/FTB

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Table 3 – Requirements for Smooth LLDPE Liner

Property	Test Method	Requirements (Nominal Thickness) *		
		30 Mil	40 Mil	60 Mil
Density, g/cc	ASTM D1505	0.915	0.915	0.915
Tensile Properties	ASTM D638 (Type IV at 2 in/min)			
Yield Stress, lb/in		45	60	94
Break Stress, lb/in		128	170	255
Yield Elongation, %		13	13	13
Break Elongation, %		800	800	800
Tear Resistance, lb	ASTM D1004	17	22	33
Puncture Resistance, lb	ASTM D4833	51	68	102
Carbon Black Content, %	ASTM D1603	2-3	2-3	2-3
Carbon Black Dispersion	ASTM D5596	Cat 1-2	Cat 1-2	Cat 1-2
Seam Properties	ASTM D4437 (1 inch wide at 2 in/min)			
Shear Strength, lb/in		44	58	90
Peel Strength, lb/in **		39/FTB	50/FTB	90/FTB

Table 4 – Requirements for Textured LLDPE Liner

Property	Test Method	Requirements (Nominal Thickness) *		
		30 Mil	40 Mil	60 Mil
Density, g/cc	ASTM D1505	0.915	0.915	0.915
Tensile Properties	ASTM D638 (Type IV at 2 in/min)			
Yield Stress, lb/in		44	58	87
Break Stress, lb/in		60	80	120
Yield Elongation, %		13	13	13
Break Elongation, %		350	350	350
Tear Resistance, lb	ASTM D1004	17	23	35
Puncture Resistance, lb	ASTM D4833	51	68	102
Carbon Black Content, %	ASTM D1603	2-3	2-3	2-3
Carbon Black Dispersion	ASTM D5596	Cat 1-2	Cat 1-2	Cat 1-2
Seam Properties	ASTM D4437 (1 inch wide at 2 in/min)			
Shear Strength, lb/in		40	53	79

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Peel Strength, lb/in **		39/FTB	44/FTB	66/FTB
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- * All values, unless specified otherwise, are minimum average roll values as reported by the specified test methods.
- ** Film tear bond: A failure of one of the bonded sheets by tearing prior to complete separation in the bonded area.

3. Shipping and storage

Liner rolls shall be shipped to the job site in a manner not to damage the rolls. The rolls shall be stored and protected from puncture, dirt, grease, excessive heat, or other damage. They shall be stored on a prepared smooth surface (not wooden pallets) and shall be stacked no more than two rolls high.

4. Subgrade preparation

Subgrade soil shall be compacted to provide a firm, unyielding foundation for the liner. All surfaces shall be smooth, free of foreign and organic material, rocks larger than 3/8 inch, any angular rocks, and any sharp objects. Standing water or excessive moisture shall not be allowed.

5. Anchor trench

The anchor trench shall provide permanent anchoring for the liner and shall be in accordance with the drawings. The trench shall be excavated according to a daily schedule for liner installation. It shall be backfilled incrementally as needed. Backfill soil shall be compacted by rolling with rubber-tired equipment or a manually directed power tamper to provide a stable anchor trench for the liner.

6. Liner placement

Liner rolls shall be deployed using a spreader bar assembly attached to a front-end loader bucket or by other methods approved by the liner manufacturer. The liner shall be placed in the general direction of maximum slope. All of the placed liner shall be adequately ballasted by sandbags to protect it from wind uplift forces. The liner shall be placed on a daily basis and seamed and secured by the end of the workday. No construction equipment shall be allowed directly on the liner except for light ATVs and generators to power the seaming machines

The liner shall not be placed during fog, precipitation, in the presence of excessive winds, or in temperatures less than 50 degrees Fahrenheit. The liner shall be loosely laid over the foundation with sufficient slack (about 2 percent) to accommodate thermal expansion and contraction encountered during construction. Each panel shall be laid out and positioned to minimize the number and length of the geomembrane field joints and to be consistent with accepted installation practice. The methods used to place panels shall minimize wrinkles especially along field seams. When necessary, a geosynthetic rub sheet will be used under the membrane to prevent damage when dragging or moving the panels.

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7. Seaming

The primary method of seaming shall be hot shoe fusion welding. Fillet extrusion welding shall be used for repairs, T-seams, and detail work. Before fusion welding or extrusion welding, all areas that are to become seam interfaces shall be cleaned of dust and dirt. Seam joining shall not take place unless the sheet is dry and shall not be attempted when the ambient sheet temperature is below 45 degrees Fahrenheit or above 90 degrees Fahrenheit.

Hot shoe welding—Hot shoe welding shall be accomplished by a double-wedge fusion welder that produces a double track weld. All accessories shall be approved by the liner manufacturer. To produce acceptable seams for the site-specific condition, the welder shall be calibrated at the beginning of each seaming period. Seaming procedures shall be in accordance with liner manufacturer specifications.

Fillet extrusion welding—Extrusion welding equipment and accessories shall be approved by liner manufacturer. To produce acceptable seams for the site-specific condition, the extrusion welder shall be calibrated once per day at the beginning of each seaming period. Seaming procedures shall be in accordance with liner manufacturer specifications.

Seam overlap—Liner panels shall have a minimum overlap of 4 inches for hot shoe welding and 3 inches for extrusion welding. Upslope panels shall overlap downslope to provide a shingle effect for drainage.

Seaming equipment and accessories:

- Hot shoe welder, 110 or 220 volts
- Extrusion welder, 220 volts
- Grinder, 10,000 rpm, 4.5-inch side grinder with 80-grit discs
- Generator, 6.5 kW, 110/220 volt output
- Power cord, OSHA approved cords and twist-type plugs and connections
- Vacuum box test equipment, approved by the liner manufacturer
- Air pressure test equipment, approved by the liner manufacturer
- Tensiometer, capable of performing quantitative shear and peel tests

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3. Seam testing

Seams shall be tested under field conditions at the beginning of each seaming period and once in the morning and once in the afternoon. Three specimens shall be tested by a tensiometer in shear and peel modes. Test seams shall meet the requirements of Section 2 above. Each specimen shall be 1 inch wide with the grip separation rate of 2 inches per minute. All peel tests shall result in film tear bond (FTB) value. The FTB is defined as a failure of one of the bonded sheets before complete separation in the bonded area.

Nondestructive seam testing—Air pressure tests shall be performed on all double-wedge fusion seams. The air pressure test equipment and procedures shall conform to this specification and the liner manufacturer's specifications. Seal both ends of the seam to be tested. Insert the pressure needle into the seam's air channel. Pressurize the air channel through the needle to 25 to 30 pounds per square inch.

Monitor any pressure drops for 5 minutes. A loss of pressure in excess of 4 pounds per square inch or a continuous loss of pressure is an indication of a leak. Terminate the test by relieving the pressure from the opposing end of the seam. The pressure shall immediately drop to zero upon opening the opposing end of the seam. If this does not occur, the seam channel shall be checked for obstructions and retested. All defects shall be marked for repair.

Vacuum box tests shall be performed on all extrusion welds. The vacuum box equipment and test procedure shall conform to this specification and the liner manufacturer's specifications. Apply soapy water solution to the seam area to be tested. The vacuum box, equipped with a transparent viewing window, shall be centered over the seam area and a vacuum of 3 pounds per square inch shall be drawn. The seam area shall be visually monitored for any soap bubbles for 15 seconds. Seam testing shall continue by overlapping a minimum of 3 inches between each test interval. All defects shall be marked for repair.

Destructive seam testing—If required, seam samples shall be cut at no more than one sample per 500 feet of weld for destructive seam testing. All destructive seam samples shall be tested by a tensiometer in shear and peel modes to verify seams meet the requirements of Material Specification 594.

4. Repairs

All defective liner areas and bad seams shall be repaired and tested before the installation is completed.

Tears, punctures, material defects—All tears, punctures, and material defects in liner shall be repaired by installing a patch over the defective area. Surfaces of the liner to be patched shall be cleaned before the repair. To ensure proper bonding of the extrusion weld, edges of the patch material and the adjacent liner shall be properly abraded by a light grinding. This operation shall be done no more than 15

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minutes before the welding operation. The abrasion shall remove no more than 10 percent of the material thickness. All patches shall be of the same liner material and extend a minimum of 6 inches beyond the edges of the defect area. All patches shall have rounded corners and shall be extrusion welded to the liner. Alternatively, a bead of extrudate shall be placed over all holes that are less than 0.25 inch in diameter.

Seam repair—All failed seams shall be repaired by installing a cap strip over the entire length of failed seam. The cap strip shall be of the same liner material and shall extend the failed seam a minimum of 6 inches in all directions. Alternatively, the seam along the upper flap can be extrusion welded to the liner along the entire length of the failed seam.

5. Mechanical attachments

The liner shall be mechanically attached to pipe, concrete, or steel structure as shown in the drawings and according to the liner manufacturer's specification.

Pipe boots—Pipe boots shall be fabricated in the field from the same liner as that shown in the drawings. The boots shall be welded and clamped to polyethylene pipe. They shall be clamped to nonpolyethylene pipe as shown in the drawing to provide a leak-free attachment.

Metal battens—Metal battens shall meet the requirements of Section 2 above and shall be installed according to the drawings and the liner manufacturer's specifications. The battens shall be bolted to structure concrete by epoxy coated bolts on 6-inch intervals to create a leak-free connection under submerged conditions. Bolt spacing shall be increased to 12 inches for connections above the fluid level.

Embed channel—HDPE embed channel shall meet Section 2 above and be installed according to drawings and the liner manufacturer's specification. The embed channel shall be prefabricated to the dimensions as shown in the drawings. All sections of the channel shall be welded to the next section continuously to prevent gaps between sections or pieces of the embed channel before their installation in the concrete forms. All corners shall be miter cut and welded all around.

6. Gas vents and drainage

When specified, gas vent flaps or vent pipes shall be installed in accordance with the drawings to provide adequate venting for the liner system. Drainage systems will be installed as specified and as shown on the drawings.

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7. Placement of cover soil (optional)

Cover soil and its placement method shall be in accordance to the drawings and shall conform to this specification and liner manufacturer's specification. Cover soil material shall not consist of any angular rocks or sharp objects that could damage liner. Placement shall be by a loader or bulldozer. No construction equipment or machinery shall be allowed to drive directly on the liner. A minimum of 12 inches of cover soil is required under the tracks or tires of construction equipment, with ground pressures of less than 5 pounds per square inch, before operating on the liner. The depth of cover soil shall be proportionally higher for heavier equipment. Cover material shall be placed during the cool times of the day or at night to prevent liner folds.

8. Placement of concrete

Concrete placement for ramps and other appurtenances shall be in accordance to the drawings and specifications. All reinforcement steel shall be placed on flat-footed plastic rebar chairs. All rebar splices shall be fully tied to avoid loose ends. On slopes, concrete shall be placed from the bottom of the slope to the top and have a low slump to prevent sloughing down slope during placement. Only plastic shovels and internal vibrators shall be used to place concrete. Metal shovels and rodding are not allowed. Concrete forms shall be held in place by methods that avoid damaging the liner.