

POLYPROPYLENE GUIDE SPECIFICATION

Table of Contents

1	General.....	2
2	References	2
3	Scope of Work	2
4	Manufacturer / Fabricator / Installer Information	2
5	Products	2
6	Submittals.....	3
7	Factory Fabrication.....	3
8	Inspection and Testing of Factory Seams.....	3
	8.1 Inspection.....	3
	8.2 Testing	3
9	Certification and Test Reports	4
10	Panel Packaging and Storage	4
11	Installation and Seaming	4
	11.1 Subgrade Preparation (New Excavation)	4
12	Concrete Impoundment	5
	12.1 Geomembrane Installation	5
	12.2 Cover Soil Placement (if required)	5
	12.3 Field Seams	6
13	Warranty.....	8
14	Appendix A: Product Specifications.....	9

1 General

The purpose of this document is to guide the user in the fabrication and installation of Polypropylene geomembrane.

2 References

- 2.1 ASTM D751, Standard Test Methods for Coated Fabrics
- 2.2 ASTM D413, Standard Test Methods for Rubber Property – Adhesion to a Flexible Substrate
- 2.3 National Sanitation Foundation (NSF) Standard 54, Flexible Membrane Liners
- 2.4 EPA/530/SW-91/051, Inspection Techniques for the Fabrication of Geomembrane Field Seams
- 2.5 ASTM D4437, Standard Practice for Determining the Integrity of Field Seams

3 Scope of Work

The work covered by these specifications consists of installing a fabric reinforced Polypropylene (RPP) geomembrane, in the areas shown on the project drawings. All work shall be done in strict accordance with the project drawings, these specifications and the Fabricator's approved shop drawings.

Sufficient material shall be furnished to cover all areas as shown on the drawings including seam areas, anchor trenches and appurtenances as required. The Fabricator/Installer of the liner shall allow for any anticipated or planned shrinkage or wrinkles in the field panels, installing the membrane free of stress or tension.

4 Manufacturer / Fabricator / Installer Information

The following shall be the minimum information submitted at the time of the bid, relating to the RPP Manufacturer, proposed Fabricator and Installer: Name, Address, Phone, Fax, Qualifications of the individuals who will personally be assigned to the project.

5 Products

The geomembrane material shall be scrim-reinforced Polypropylene (RPP) as manufactured by Cooley Engineered Membranes, of Pawtucket, RI. Thickness and material type shall be Black/Black 36 mil nominal. The geomembrane shall be manufactured by the extrusion / calendaring process, consisting of first quality ingredients, suitably compounded with sufficient additives to ensure long-term durability. The finished membrane shall be uniform in color, thickness, size and surface texture.

The finished membrane shall consist of two (2) plies of polypropylene laminated over one (1) ply of reinforcing scrim. The scrim shall be fully encapsulated with the encapsulation

extending a minimum of 1/8" beyond the scrim edges. Exposed fabric along the length of the roll stock shall not be permitted. The finished membrane shall meet or exceed the "physical properties" values as shown in the Product Specification (Appendix A).

6 Submittals

The RPP roll goods shall be factory fabricated into large panels. Field Seaming roll stock in the field will not be allowed. The Fabricator shall furnish a proposed geomembrane panel layout to be approved in writing by the Engineer prior to material shipment. The drawings shall show: the direction of factory seams, the size of panels, and the location of field seams, consistent with the requirements of the project drawing. These details shall include the recommended termination details of the geomembrane. Except for special requirements due to configuration and/or terminating the geomembrane, maximum use of large size panels shall be made to reduce field seaming to a minimum.

7 Factory Fabrication

The Fabricator shall be an experienced firm customarily engaged in factory-fabricating individual widths of scrim-reinforced geomembrane roll stock into large panels. The fabricator shall have experience in fabricating a minimum of 1,000,000 square feet of geomembrane by thermal fusion methods. Approved Fabricator & Installer: Lange Containment Systems, Inc. – Denver, CO (303) 446-8644.

Prior to factory seaming, all roll goods shall be inspected. All factory seams shall be made by thermal fusion methods. All factory seams shall have a minimum scrim-to-scrim overlap of one and one-half inches (1 ½") when fabricated. Fabricated seams found to have less than the specified minimum overlap shall be repaired by adding an overlap or cap strip that provides the minimum specified overlap or it will be rejected. All seams shall be made so that thermal fusion bond extends fully along the width of the sheet so that no loose edges are present.

8 Inspection and Testing of Factory Seams

8.1 Inspection

All sheets and seams shall be 100% visually inspected during fabrication. No defective seams or exposed scrim will be allowed. All exposed scrim edges shall be sealed with an approved PP edge caulk, capped with a strip of PP or extrusion welded. All indicated repairs shall be made by the geomembrane Fabricator before the panels are packaged for shipment.

8.2 Testing

In addition to visual inspection, a 48-inch (1.2m) weld sample shall be made with each factory seam welding unit used in this work at the beginning of every work shift and every four hours of production thereafter. Sample shall be taken from a seam specifically made for quality testing and not taken from the fabricated panel itself. Test specimens shall be cut at quarter points from each 48-inch seam sample (a total of three places) and tested for seam

strength and peel adhesion. The shear seam strength shall be tested in accordance with ASTM D751 as modified in Annex A of ANSI/NSF 54. The peel adhesion shall be tested in accordance with ASTM D413 as modified in Annex A of ANSI/NSF 54.

A log shall be maintained showing the date, time, panel number and test results. Failure of the material and/or seams to meet all the requirements of these specifications may be cause for rejection of the material and/or seams as appropriate. The Fabricator shall provide the test results to the Owner or Engineer upon request.

9 Certification and Test Reports

Prior to installation of the PP panels, the approved Fabricator / Installer shall provide the Engineer with the following certification and test reports:

- Written certification that the material meets the material property requirements in the Product Specification (Appendix A).
- Written certification that the factory seams were inspected and tested in accordance with Section 8.2.

10 Panel Packaging and Storage

Each factory-fabricated panel shall be accordion folded in one direction and rolled and placed onto a sturdy wooden pallet designed to be moved by a forklift or similar equipment. Each panel shall be given prominent and unique identifying markings indicating the proper direction of unrolling and/or unfolding to facilitate layout and position in the field. The panels shall be suitably packaged, enclosed and protected to prevent damage during shipment and each package shall be prominently marked in the same fashion as the panels within. Until needed, packaged factory fabricated panels shall be stored in their original unopened containers in a dry area, and protected from the direct heat of the sun, where possible. Pallets should not be stacked.

11 Installation and Seaming

11.1 Subgrade Preparation (New Excavation)

The surfaces on which the lining is to be placed shall be maintained in a firm, clean, dry and smooth condition during the lining installation. All surfaces shall be compacted and smooth graded with anchor trenches provided as required and detailed. All surfaces to be lined shall be free of rocks, roots, gravel, grade stakes or debris that may puncture the geomembrane. The subgrade shall be compacted to a minimum of 95% of the dry density (as determined by ASTM D398 Standard Proctor Method). Geotextiles may be used as a cushioning agent. All vegetation, if present, shall be removed and if required by the Engineer, a soil sterilant applied. The soil sterilant shall be selected for the geographical area and native grasses and growth.

If groundwater is present within 12 inches below the surface to be lined, the General Contractor shall dewater the area prior to and during installation of the liner.

Immediately prior to the installation of the geomembrane, the Field Engineer, Earthwork Contractor and the Geomembrane Installer shall perform a complete and detailed inspection of the embankments to determine acceptance of the finished subgrade and elevations. The Earthwork Contractor shall correct any erosion or other damage to the base material that has occurred since placement.

12 Concrete Impoundment

Ensure the surface is clean and free of debris that can damage the liner during construction. Any badly spalled or cracked concrete shall be grouted or similar treatment. In some cases, a needle-punched geotextile can be placed over the damaged concrete or similar subgrade prior to installation of the liner.

12.1 Geomembrane Installation

The geomembrane shall be placed over the prepared surfaces in such a manner as to insure minimum handling and in accordance with the approved shop drawings. The lining shall be sealed to all concrete structures and other openings in accordance with details shown on the plans and shop drawings. The geomembrane shall be closely fitted and sealed around all inlets, outlets and other projections through the lining, using prefabricated fittings where possible as shown in the construction details. Liner sheets, damaged from any cause, shall be repaired or covered with additional sheeting.

Only those sheets of lining material that can be anchored and seamed together the same day shall be unpackaged and placed into position. In areas that high wind is prevalent, the lining installation should begin on the upwind side of the project and proceed downwind. The leading edge of the liner shall be secured at all times with sandbags sufficient to hold it down during high winds. The leading edges of the liner material left exposed after the day's work shall be anchored to prevent damage or displacement due to wind.

Materials, equipment or other items shall not be dragged across the geomembrane surface or be allowed to slide down slopes on the lining. All parties walking or working on the liner shall wear soft-sole shoes. No smoking shall be permitted on the liner.

12.2 Cover Soil Placement (if required)

The earthwork contractor shall place the soil cover layer over the liner system on a daily basis as soon as a lined area of the facility has been completed and accepted by the owner.

Extreme care shall be taken by the earthwork contractor not to damage the liner system during the cover soil placement. A minimum of 12 inches of cover soil is needed prior to placing any earth-moving machinery over the liner system. The soil and rock particles of

the cover material shall be of such size and shape as not to damage the liner. The upper particles' size limit is usually 3/8 inch. Angular or sharp rock fragments are not allowed.

The earthwork contractor should conduct a test on the job site simulating field subgrade, liner system, and cover soil placement. The earthwork contractor should use the proposed method of cover soil placement and equipment to verify the integrity of the liner. The liner installer is not responsible for damage to the liner as a result of using unsuitable cover material or improper methods of cover placement over the liner. That is the responsibility of the earthwork contractor.

Cover soil shall be placed on side slopes from the bottom to the top of the slope. During the cover soil placement, the driver shall not make sharp turns or sudden starts and stops. The machinery speed shall be slow. Frozen soils are not to be used as cover material unless screened prior to placement.

Cover soils shall be placed during the coolest time of the day to prevent folds in the liner. Special techniques shall be implemented to isolate small liner ripples and prevent the liner from folding over itself during cover soil placement.

12.3 Field Seams

12.3.1 General

Lap joints shall be used to seal factory fabricated sheets together in the field. The lap joint shall be formed by lapping the edges of the sheets four (4) to six (6) inches. The contact surfaces of the sheets shall be wiped clean of all dirt, moisture, and other foreign matter. A minimum of one and one half inch (1 ½") bond shall apply to all liner field seams.

Avoid fishmouths, wrinkles, folds or pleats in the same area. Where fishmouths do occur, they should be slit out far enough from the seam to dissipate them, lapped, seamed together in the lapped area and patched. Any necessary repairs to the PP geomembrane shall be done using an additional piece of the specified PP sheeting applied as stated in Section 11.4.2 of this specification. All patching material shall have rounded edges.

Cleanup within the lining compound shall be an ongoing responsibility of the Lining Contractor. Particular care should be taken to ensure that no stones, scrap material, trash, tools or other unwanted items are trapped beneath the geomembrane liner.

All field seams shall be made utilizing hot air or hot wedge welding techniques as outlined in appropriate sections of the EPA Technical Guidance Document: "Inspection Techniques for the Fabrication of Geomembrane Field Seams." All relevant information shall be recorded on the attached Destructive Failure Report or equivalent

12.3.2 Cold Weather Seaming

Seams shall be welded only when ambient temperature is between 32°F and 110°F as measured six inches above the geomembrane surface unless the Engineer approves other limits, in writing. For temperatures below 32°F, the following procedures shall be utilized:

When the weather is clear and sunny with gentle winds (10 mph or less) welding can normally be performed at an ambient temperature between 32°F and 15°F (liner temperature is usually warmer than ambient due to the sun) without additional provisions other than adjusting the welding machine. Welding temperatures and machine speeds are adjusted to compensate for cloudy weather and higher winds (up to 25 mph).

For temperatures between 15°F and 5°F some means of preheating the liner other than that provided by the welding machine is needed. Details of the preheating (space heaters, temporary shelters and combinations of the two) will be determined by the individual job conditions. The following variables are measured and recorded:

- Liner Temperature (surface contact thermometer)
- Ambient Temperature (6" above liner)
- Wedge Temperature During Welding
- Wedge Speed
- Temperature Set Point of Wedge

The wedge temperature during welding must be observed and recorded. After starting a seam the temperature is observed and recorded every 20 feet for the first 60 feet or until the wedge temperature appears to have stabilized. After the temperature has stabilized the wedge temperature is observed and recorded every 15 minutes.

No welding can take place when it is snowing, sleeting, or raining. Snow and ice must be moved from the liner prior to welding. Snow removal is the responsibility of the owner or contractor. Snow blowers are typically used to remove the top portion of snow leaving the lower 2 to 3 inches above the liner to be carefully removed by hand using plastic shovels or brooms.

12.4 Inspection and Testing of Field Seams

12.4.1 Inspection

Upon completion of the liner installation, all seams shall be visually inspected for compliance with these specifications. In addition to visual inspection, all field seams shall be checked using an air lance nozzle directed on the upper edge and surface to detect any loose edges or ruffles indicating unbonded areas within the seam (ASTM D 4437).

All field seams shall be tightly bonded on completion of the work. Any geomembrane surface showing injury due to scuffing, penetration by foreign objects, or distress

from other causes shall be replaced or repaired. All exposed scrim edges shall be sealed with an extrusion weld or capped with a strip of polypropylene.

12.4.2 Repairs

Any repairs made to the liner shall be made with lining material supplied by Cooley Engineered Membranes. For the best welding performance, the repair should be made with newly manufactured material. Patches shall be cut with rounded corners and shall extend a minimum of four (4) inches in each direction from the damaged area. The entire surface of the patch shall be bonded to the PP lining material. If reinforced patches are used, the cut edges of the patch should be coated with an approved sealant or sealed with an extrusion weld.

12.4.3 Testing of Field Seams

Destructive test seams are to be made by each seaming crew, at the beginning of the seaming process and every four (4) hours thereafter, or every time equipment is changed. Test seams shall be made under the same surface and environmental conditions as the production welds (i.e., in contact with geomembrane subsurface and similar ambient temperature). These seams are to be made of like materials provided for the purpose of testing and not cut from the seamed panels. Each seaming crew and the materials they are using must be traceable and identifiable to their test seams. The samples shall be numbered, dated and identified as to the personnel making the seam, and location made by appropriate notes on a print of the panel layout for the project. The completed field seam sample shall measure not less than 14 inches in width and 24 inches in length.

The sample field seam shall be destructively tested to ensure a film tear bond is achieved. Once the field seam demonstrates a film tear bond the field seaming may commence.

If a test seam fails to meet the field seam design specification, then the seaming crew shall make additional test seam samples, using the same tools, equipment, environmental conditions and seaming materials and retested until a passing or film tear bond is achieved.

13 Warranty

- 14 Destructive test seams are to be made by each seaming crew, at the beginning of the seaming process and every four (4) hours thereafter, or every time equipment is changed. Test seams shall be made under the same surface and environmental conditions as the production welds (i.e., in contact with geomembrane subsurface and similar ambient temperature). These seams are to be made of like materials provided for the purpose of testing and not cut from the seamed panels. Each seaming crew and the materials they are using must be traceable and identifiable to their test seams. The samples shall be numbered, dated and identified as to the personnel making the seam, and location made by

appropriate notes on a print of the panel layout for the project. The completed field seam sample shall measure not less than 14 inches in width and 24 inches in length.

- 15** The sample field seam shall be destructively tested to ensure a film tear bond is achieved. Once the field seam demonstrates a film tear bond the field seaming may commence.
- 16** If a test seam fails to meet the field seam design specification, then the seaming crew shall make additional test seam samples, using the same tools, equipment, environmental conditions and seaming materials and retested until a passing or film tear bond is achieved.

**** End of Specification ****

APPENDIX A

Product Specifications

36 mil Polypropylene Geomembrane – Physical Properties NSF 61 Approved

Physical Property	Test Method	Standard	Metric
Thickness (±10 %)	N/A	36-mil	.91 mm
Type of Coating	N/A	Polypropylene	
Coating Distribution	N/A	50/50	
Breaking Strength, lbf (kN) Warp (MD) Fill (TD)	ASTM D 751A	275 lbs 250 lbs	1220 N 1110 N
Tearing Strength Warp (MD) Fill (TD)	ASTM D751 B (mod)	70 lbs 70 lbs	311 N 311 N
Wide Width Strength Warp (MD) Fill (TD)	ASTM D4885	150 lbs/in 125 lbs/in	262 N/cm 219 N/cm
Hydrostatic resistance	ASTM D751A	350 psi	2.4 MPa
Puncture Resistance	FTMS 101C, 2031	300 lbs	1330 N
Ply Adhesion	ASTM D751 (mod)	40 lbs/2 in *	178 N/5 cm *
Dimensional Stability	ASTM D 1204	1 % max	1 % max
Low Temperature	ASTM D 2136	-40 °F	-40 °C
Abrasion Resistance (H18 / 1kg)	ASTM D3884	5,000 cycles	5,000 cycles
Stress Crack Resistance	ASTM D1693	3,000 hrs	3,000 hrs
UV Resistance (black)	ASTM G154	35,000 hrs	35,000 hrs
Ozone Resistance (100 pphm, 14 days)	ASTM D 1149	No Cracks	No Cracks
Bonded Seam Strength	ASTM D751, NSF Mod	200 lbs	890 N
Peel Adhesion	ASTM D413	20 lbs/in *	35 N/cm *

*Ply adhesion and Peel adhesion testing may result in a film tearing bond (FTB) if the strength between layers is greater than the strength of the material itself.

A variety of standard widths and colors are available including **NSF 61 certified** material.