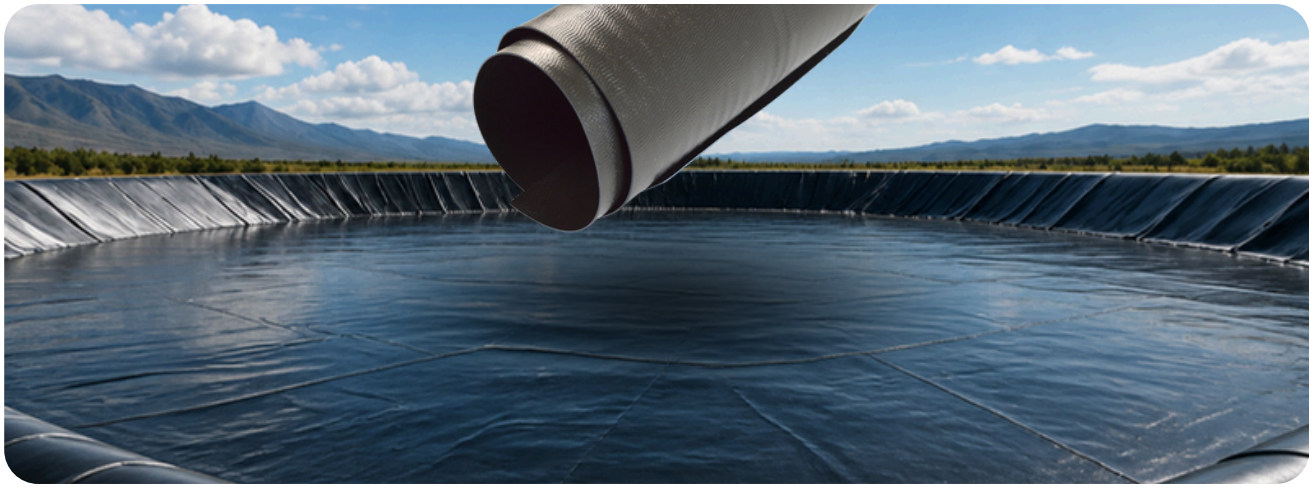
Manufacturer of High-Performance Fluoropolymer Films, Laminates, and Composites

Design and Installation Guide for TCI EverLiner™ 2130 Geomembrane System



Chemical Resistance

High Temperature Resistance

Ultraviolet Resistance

Long Service Lifespan

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DESIGN CONSIDERATIONS

This Guideline contains information on suggested design and installation considerations for the TCI EverLiner™ 2130 PTFE Geomembrane. Apart from general recommendations on the use of the geomembrane, this guideline also provides some general information on material, project site, suitability, design, and installation considerations. Relatively minor projects and small containments or tank secondary liner projects can be designed or carried out by the owner or the general contractor. However, in the case of larger commercial installations the design is often considerably more complex. In these installations, it is recommended that a licensed engineer be consulted to ensure that the project is designed in accordance with applicable local and international standards and will ultimately perform as required.

Product Description and Unique Characteristics

PTFE, or Polytetrafluoroethylene, is one of the family of fluoropolymers well known in many industrial applications for superior chemical resistance and high temperature properties. Since the EverLiner™2130 geomembrane produced from PTFE is inert across the full pH range of 0-14, the corrosion or degradation variable is eliminated. Even with long term exposure to severe chemicals, the properties of PTFE will not change. Additionally, the temperature range of PTFE is -400°F to 600°F (-240°C to 316°C) which eliminates any concern for liner failure due to very high temperature exposure. This includes the biodegradation temperature of 149°F (65°C) commonly found in landfills that has caused premature failure in traditional geomembrane materials such as HDPE. For any exposed application, the PTFE is inert also to UV degradation and oxidation. The PTFE is truly a fully inert and sustainable material that can be utilized in any application which is designed to protect the environment forever as an undisturbed geomembrane.

Aging of polyolefinic geomembrane materials such as HDPE, LLDPE and PP leads to time-dependent physical and chemical changes, affecting their multifunctional properties profile. Elevated temperatures induce post-crystallization associated with morphological changes that will ultimately result in the liner degradation and failure. Time dependent failures are further accelerated by higher-than-normal temperatures and extreme chemical environments while in service. In fact, degradation of current polymers as in geosynthetic materials is reportedly contributing to the worldwide Microplastics Contamination. Because the PTFE is 100% Polymer and will not degrade or corrode over time, the EverLiner™ 2130 Geomembrane will not contribute to the ever increasing worldwide environmental problem of Microplastics pollution that is the direct result of today's plastics/polymer industry and production methods. Additionally, the fact that the EverLiner™ 2130 Geomembrane will not degrade over time (unlimited lifetime design) will allow for an economic benefit for significant levelized costs for a given application as compared to other polymeric geomembranes with very limited lifetime in extreme conditions. Project Longevity and the Cost/Benefit Factor of specifying PTFE geomembranes over conventional products cannot be overstated.

As a product manufacturer, TCI does not perform geotechnical or other design functions. The following information is provided as a general guideline and for design and construction considerations only.

Geomembrane Material Considerations

1. Geomembrane:

- The EverLiner™ 2130 Geomembrane is a synthetic 100% PTFE membrane. The panels specifically designed for a project are assembled from roll goods in the factory up to 16,000 sq ft and an estimated 5000 lbs thus limiting on-site field seaming. The panels are folded and rolled on cores that are customized in width and length.
- Refer to the EverLiner™ 2130 TIS for physical property values and factory panel sizes.
- Thickness's: 30 mil is standard with 10 to 60 mil available upon request.
- Each roll or prefabricated panel is labeled with the membrane type, thickness, dimensions, weight, manufacture date, and production lot, and arrows indicating direction of unroll/unfold as well as position at the site.
- Large Panel Custom Sizes for Drop-in Tank Linings and Secondary Containment (No Field Welding Required).

2. Protection Geotextiles and Geonet Composites placed against the EverLiner™ 2130 Geomembrane

- A protection nonwoven needle punched geotextile of minimum 10 oz/sqyd is acceptable as an underlayment.
- Geonet composites are also acceptable as an underlayment for drainage and venting.
- A Geonet Composite must have at least one side geotextile facing up against the EverLiner™ Geomembrane.
- Exposed edges of the geonet must be covered with one or two layers of the overlying geotextile to protect the geomembrane from sharp cut edges.
- Minimum Geotextile on a composite must be 6.0 oz/Syd and needle punched nonwoven.
- Geotextiles or Geonet Composite provide a clean working surface for geomembrane installation and seaming.
- Conductive geotextiles can be used under the EverLiner™ 2130 for use in Electrical Leak Location (ELL) testing.

Application Suitability and Chemical Resistance

1. The EverLiner™ 2130 Geomembrane System is appropriate for any of the following conditions or installations:

- Water and Wastewater Containment
- Highly Chlorinated Water – Long Term Tank Containment
- Pit Thermal Energy Storage (PTES) and LTES) (range 90°C – 95°C)
- PTES Floating Cover Systems
- Bioreactor (High Temperature) Landfills and Hazardous Waste Brownfields Biocells
- Hazardous Waste and Caustic Waste Effluent Canals
- Fuel secondary containment and fuel bladders
- Hot Brine / Hot Liquid Containment
- High Temperature Solar / Geothermal Containment
- Mining Process Water Containment and Solution Canals
- Chemical plating processes
- Mining Acidic Waste Rock Leachate Containment
- Tank Lining Systems – Drop-in Prefabricated and double tank bottoms
- High Temperature Caustic Chemical Lining System
- Municipal or Hazardous Waste Landfill Liner System – Primary and Secondary Forever Lining System

2. The EverLiner™ 2130 Geomembrane System is not appropriate where any of the following conditions exist:

- Any containment where the substrate will not provide continuous and uniform support.
- Any containment exposed to high wind uplift conditions without proper ballasting or cover systems.
- Any containment that will be subjected to high groundwater conditions without proper ballast design.

3. The EverLiner™ 2130 Geomembrane System is not recommended without approval by a design engineer where any of the following conditions exist:

- Where the side slopes exceed 2H:1V in excavated or compacted soils or cover soils are required (slope stability).
- Where highly erodible or collapsing soils or karst terrain are present below the liner system.
- Where organic gases or trapped air will be generated or could exist below the liner system.
- Where the concrete base is old and shows signs of deterioration.
- Where radioactive waste materials or components are present – Consult TCI for recommendations.

Chemical Resistance Comparisons for Long Life

CHEMICAL	PVC-EIA	HDPE	PVDF	PTFE
Acetic acid (50%)	Chemically attacked	Chemically resistant	Chemically resistant	Chemically resistant
Acetone	Chemically attacked	Chemically resistant	Chemically attacked	Chemically resistant
Ammonium hydroxide	Chemically attacked	Chemically resistant	Chemically attacked	Chemically resistant
Benzene	Chemically attacked	Chemically attacked	Chemically resistant	Chemically resistant
Diesel	Chemically resistant	Chemically attacked	Chemically resistant	Chemically resistant
Ethyl acetate	Chemically attacked	Chemically resistant	Chemically attacked	Chemically resistant
Furfural	Chemically attacked	Chemically resistant	Chemically resistant	Chemically resistant
Gasoline	Chemically resistant	Chemically attacked	Chemically resistant	Chemically resistant
Methyl ethyl ketone	Chemically attacked	Chemically resistant	Chemically attacked	Chemically resistant
Methyl isoamyl ketone	Chemically attacked	Chemically resistant	Chemically attacked	Chemically resistant
Nitric acid (50%)	Chemically attacked	Chemically attacked	Chemically resistant	Chemically resistant
Perchloroethylene	Chemically attacked	Chemically attacked	Chemically resistant	Chemically resistant
Phenol	Chemically attacked	Chemically resistant	Chemically resistant	Chemically resistant
Sulphuric acid	Chemically attacked	Chemically resistant	Chemically attacked	Chemically resistant
Toluene	Chemically attacked	Chemically attacked	Chemically resistant	Chemically resistant
Xylene	Chemically attacked	Chemically attacked	Chemically resistant	Chemically resistant

Project Site and Substrate Considerations

1. Site Selection – When selecting the construction site, there are numerous design elements that must be considered to ensure long-term performance of the system and to avoid future problems:

- The nature of the soil substrate and subsurface rock
- The presence of cavities (karst terrain)
- The depth to and the variation of the groundwater level
- The presence of gases in the soil (i.e., peat, organic matter)
- The risk of differential settling (i.e., poorly consolidated soil, recent backfill, landfills)
- The risk of internal erosion (i.e., karst soils, fine silty sands)

2. Site Excavation – The configuration of the impoundment is usually constructed by one of the following methods:

- Fully excavating into the natural soil
- Building raised embankments
- Partial excavation with raised embankments

3. Soils

- A thorough geotechnical investigation of the site should be conducted to ensure that the underlying soil will remain stable. Investigation must include current and seasonal groundwater levels.
- The type of soil (classification) density, permeability, thickness of the strata, and the depth under the lining system must be known.
- The soil supporting the Geomembrane system should be compacted smooth to minimum 95% of Standard Proctor density by mechanical vibratory roller.
- Soil ridges should not exceed 1.0 inch.
- Loose aggregate should not exceed 0.5 inch in size.
- Saturated soil areas or ponded water is not allowed prior to placement of the Geomembrane.

The base of the containment should be sloped a minimum of 1% to the sides to provide the following:

- Correct operation of the drainage system.
- Easy maintenance, draining and cleaning of the containment (if unprotected).
- Positive gas movement under the lining system.
- Side Slopes for the Containment should generally be 3H:1V or flatter unless the soils are determined to support slopes greater than 3H:1V. All cover materials must be designed for stability and interface shear resistance by a design engineer.
- Top of Slope anchorage should be conventional anchor trench or mechanical connection.
- The base of the containment should have slight incline of 1% towards the outside of the toe of slope on all sides for gas or water drainage. The slope can be from the center to the sides or from one side to the opposite side.

4. Drainage

The design requirement for a drainage layer beneath the geomembrane must be addressed by the design engineer and will depend on local site conditions and the presence of high groundwater, organic waste or potential for flooding of the area. Water drainage and gas drainage are often combined. For this reason, a minimum slope of 1% of the base toward the side slopes is recommended. Water and gas drainage may be facilitated by means of one or more of the following:

- A layer of cohesionless soil (sand or fine gravel) with a minimum thickness of 6 to 12 inches.
- A continuous layer of geonet composite or intermittent strips of geonet composite.
- A double lining system with a drainage layer (geonet or geonet composite) between a primary and secondary Geomembrane.
- A perimeter trench drain or vertical panel drain designed to intercept groundwater.

5. Substrate Venting

A substrate venting system for gas or air will require gas vents to be installed top of slope as shown in the detailed drawings. Vents are usually placed top of slope above maximum water level and spaced 25 ft to 50 ft OC around the perimeter. Venting systems should be designed by a professional engineer.

6. Impoundment Shape and Length and Wave Action

- Waves created by the wind will cause an impact on the side slopes. The greater the length of the impoundment in the direction of the prevailing winds and the steeper the slope, the stronger the wave action will be.
- Depending on the specific height of the waves, the type of soil and the slope of the embankments, one or a combination of the following is recommended:
  - Geomembrane protection to the slope (concrete, concrete block mattress, rip rap, stone filled geocell, soil cover)
  - Provide adequate anchoring of the Geomembrane lining system to include ballast tubes on slopes.
  - Provide adequate compaction of the base soil to minimum 95% standard proctor density.
  - Provide geotextile protection under the Geomembrane lining system to prevent soil sloughing on slopes.

7. Wind Uplift

- In areas of high wind, ballasting with sand tubes on slopes, toe of slope and bottom (if exposed) will be necessary.
- Temporary ballasting may be removed once permanent ballast is installed (i.e. water, cover soils, ballast tubes, etc.)

8. Maximum Liquid Level and Freeboard:

Maximum liquid level should be at least 2.0 ft below the top of the impoundment for a 3H:1V slope. If lower slopes are anticipated or high waves will be experienced, the freeboard should be increased to greater than 2.0 ft.

9. Additional precautions and/or protection may be required in the following situations:

- Wind
  - Ballast at the bottom, toe of slope and on slopes
  - Mechanical connections to structures and anchor points

- Waves
  - Mechanical protection of the embankment slope both under and over the geomembrane
  - Floating Objects and Ice – Mechanical slope protection

- Animals and Vandalism
  - Mechanical Protection
  - Enclosure fence around Containment Area
  - Geotextile Protection under Geomembrane on slopes

- Operation of Vehicles
  - Protection with a soil layer minimum 18 inches in depth
  - Access ramp and concrete cleanout pad designed for equipment travel
  - No tracked equipment > 5 psi ground pressure over protected areas.
  - No rubber-tired vehicles allowed on the liner system

Structural Connections and Penetrations

- Anchor Trenches

An anchor trench is commonly used as a perimeter termination. The trench is excavated, and the membrane is loose laid in it. The trench is then backfilled and compacted with the excavated material or concrete.

- Intermediate Anchoring

If the embankment is high with long slopes, it may be necessary to provide intermediate anchoring to reduce the potential for membrane movement. In these cases, a bench may be added along the slope to provide stability of the geomembrane. The bench can then be soil covered or utilized for mid-slope access by equipment.

- Toe of Slope / Bottom Ballast

In some cases, especially on large containments, temporary and/or permanent ballast (soil cover) may be required due to operating conditions or wind conditions. Additionally, and especially on embankments, a toe of slope anchor trench or concrete base connection may be required.

- Inlet Pipe or Concrete Structure Terminations

Where water or other liquid enters or exits the lined area special considerations must be made for terminating the membrane to ensure that the termination remains intact. This may include prefabricated pipe boots or mechanical batten bar connections. Inlet splash pad or mechanical protection may also be required.

- Mechanical Terminations

Mechanical terminations shall be in accordance with Design specifications and detailed plans and specifications prepared by the design engineer.

EverLiner™ 2130 Geomembrane Factory and Field Seaming Procedures

Due to the unique chemical and heat resistance properties of PTFE as well as high melt temperatures, thermal seaming procedures are specialized and restricted to the following:

Hot Plate Welding with PFA thermal strips (used on production seams with overlaps)

PFA overlap strips are similar to PTFE characteristics but lower in melt temperatures and thus can be used to form a bond between overlapping sections of PTFE. Factory and Field welding shall be carried out only by TCI approved facilities and/or TCI trained technicians using seaming equipment designed and developed by TCI. It should be noted that most installations are designed with one or two panels thus reducing the requirement for field seaming. Conventional thermal welding equipment is not approved for PTFE production seams in the factory or field.

Cover Material Considerations

1. Cover soil and graded aggregate can be installed over a geotextile protected EverLiner™ 2130 Geomembrane System for a variety of reasons:

- To provide protection from mechanical damage
- To provide additional protection from intense wildlife or equipment traffic
- To provide a more aesthetically pleasing appearance on exposed slopes
- To provide access roads or access ramps over lined areas

2. Concrete and shotcrete can also be installed over and adjacent to the Geomembrane System to provide support pads or access ramps for equipment such as aerators, agitators, or other mechanical equipment.

3. In all cases, a nonwoven protection geotextile should be specified between the Geomembrane and soil, rock or concrete. The geotextile should be a nonwoven needle punched fabric minimum 10 oz/syd mass per unit area. Slope stability and interface shear strength between layers must be provided by a design professional.

Quality Assurance (Fabricator and Installation Contractor Experience)

1. A TCI trained and approved Fabricator and Installer is required to properly layout and thermal seam the EverLiner™ 2130 Geomembrane System for issuance of a TCI material warranty.

2. The TCI Technical Department is available to discuss any deviations from the TCI Geomembrane Guidelines, Specifications and Details.

Construction Quality Assurance (CQA) and ELLS

2. Critical installations may require third party CQA for inspection of the project and compliance with the design specifications and drawings. As part ot the CQA procedures, an Electrical Leak Location Survey (ELLS) may be required in general accordance with ASTM D 7007. ELLS is generally recommended as a final step in the CQA process prior to final acceptance and approval.

INSTALLATION GUIDELINES

Furnish and completely install the EverLiner™ 2130 Geomembrane System in accordance with TCI published Installation Procedures, guidelines, specifications, and details as well as project design requirements.

Submittals

1. Panel Layout

- The installation contractor shall provide a panel layout, drawing or plan.
- The panel layout drawing shall be based on the specification and design details and will show the position and size of each panel and location of field seams.
- The placement of the panels will proceed according to this plan unless changes must be made due to unforeseen site conditions.

2. Installation Details

The installation contractor shall provide copies of any special detail terminations that may be required for approval by the design engineer and TCI. Refer to published details such as provided by the FGI or ASTM.

Material Storage and Handling Considerations

1. Storage and Handling

- Store EverLiner™ 2130 Geomembrane panels in the original factory container or on pallets to protect them from site damage, equipment and standing water. Care should be taken not to damage the Geomembrane panels during transport, loading, and unloading. The panels must be stacked on a flat, clean surface, free of sharp protrusions that could damage the geomembrane.
- EverLiner™ 2130 panels can be up to 16,000 sqft in size and weigh over 5000 lbs. Therefore, proper moving and lifting equipment is required that must be compliant with local and federal guidelines for safety.
- Refer to ASTM D 7865 for detailed procedures for storage and handling of prefabricated panels.

Substrate Inspection and Preparation

1. Inspection of Support Surface

As part of Construction Quality Control (CQC) and before installing the Geomembrane panels, quality of the soil substrate or concrete and the surface condition should be examined to determine compliance with design requirements and minimum requirements for placement and seaming of the geomembrane panels.

2. Soil Preparation

The subgrade soils in intimate contact with the Geomembrane shall be smooth, compacted, and free of aggressive angle changes, ruts, loose stones, and angular stones more than 12.0 mm (0.5 in.). The subsoil should be roller compacted to minimum 95% of Standard Proctor Density and designed to resist any differential settling of the soil and facilitate the installation of a drainage system, if required. Adequate support can be provided in the following ways dependent on design requirements:

- Excavate the unsuitable subgrade base soil, remove rock, vegetation, saturated soils etc., followed by smoothing and compacting of the base.
- Backfill with layers of select fill material which are then compacted to the desired density and grade.

3. Vegetation

All plant growth should be removed from the base soil prior to grading and compaction to avoid any gas generation and compressible areas. Depending on the conditions, the use of water-based herbicide is recommended.

4. Compaction

- All soils supporting the EverLiner™ 2130 Geomembrane System must be roller-compacted smooth to 95% of Standard Proctor Density and in accordance with methods and specifications provided by the Design Engineer.
- The supporting surface should not contain any loose angular stones exceeding 12.0 mm (0.5 in.) in diameter. The final surface should be smooth and uniform with no abrupt changes in elevation.
- If site conditions and soil are not acceptable, a protection layer of minimum 10 oz/yd2 (340 gm/m2) non-woven geotextile should be provided.
- Soil around concrete structures.
- The Geomembrane liner fixed to a concrete structure must be on firm compacted soil subgrade. Compaction of backfill around structures must be performed with particular care and shall be compacted to minimum 95% of Standard Proctor Density.

Protection Layer Installation

1. Hard Substrates (concrete, soil cement, asphalt, etc.)

On hard substrates such as concrete, it is always necessary to install a protection layer geotextile of at least 10 oz/sqyd. This is particularly important if the surface is cracked, spalled or requires patching.

2. Installation of a geotextile between the subgrade soil and the Geomembrane is generally recommended. It is an absolute necessity on slopes where deposition of an additional support layer is often difficult. Depending on the type of soil and roughness of the surface, the mass of the geotextile may vary between 340 and 540 g/m2 (10 and 16 oz/yd2). Slope stability and interface shear strength between layers must be provided by a design professional.

3. Other types of geosynthetics, such as geonets, and geonet composites are also used to provide gas and water drainage as well as protection and may be required dependent on the design.

4. Protection geotextiles are usually thermally welded at overlaps using a minimum100 mm (4 inch) overlap.

EverLiner™ 2130 Geomembrane Installation

1. The panels are unrolled and/or unfolded into the position indicated on the layout plan.
2. Side slope panels are placed and temporarily ballasted (sandbags) first, followed by the bottom panels.
3. On slopes, Geomembrane panels are unrolled from the anchor trench down the side slopes, and the geomembrane is temporarily anchored to avoid movement down slope.
4. No rocks or sharp objects are allowed under the geomembrane during placement. Damage to the supporting soil or geotextile underlayment must be avoided and repaired prior to completing the layout.
5. The side slope panels should extend a minimum of 1.5 m (5.0 ft.) out on the bottom for connecting with adjoining panels.
6. All Geomembrane panels must be allowed to relax prior to seaming or attachment to structures.
7. To avoid movement and wind uplift during installation, temporary ballast (sandbags) is highly recommended.

EverLiner™ 2130 Geomembrane Field Seaming and Test Procedures

1. The field seaming of adjacent panels should be performed immediately after the relaxation of the Geomembrane. It should be noted that most installations can be completed as one or two large panels thus reducing or eliminating the need for field seaming.

2. All panels must be installed without tension and without wrinkles overlapping by a minimum of 100 mm (4.0 in.). All seams on side slopes must be parallel with the slope. Horizontal field seams on slopes are not allowed. Depending on the design and panel layout, factory seams may be allowed in the horizonal (cross slope) direction.

3. Field Seaming that may be required should not continue under the following conditions:

- Moisture
- Soft subgrade soil
- Rainfall
- Ponded water
- Excessive wind/dusty conditions
- Other contaminants

4. Clean the seam area with water and dry before thermal fusion seaming

5. Deploy only the panels that can be seamed that day – do not leave unseamed panel sections overnight.

6. Field seaming shall be carried out only by TCI approved Installation Personnel.

7. Field seam methodology shall be by Hot Plate Welding with PFA thermal strips only

Field Seam Testing

In the event that field seams are required on a project, the following is recommended:

1. Destructive Seam Testing (Trial Weld Seams)

- At the start of a shift and every 4 hours, the seaming crew should complete a trial seam of minimum 4 ft in length.
- From the trial seam, 25.4 mm (1.0 in.) wide strips are cut for testing on a field tensiometer – 5 in Peel and 5 in Shear. Shear and peel tests are carried out in general accordance with ASTM D 6392 for both peel and shear. Curing and tensiometer testing should be carried out in a temperature and humidity-controlled area such as an onsite construction trailer.
- The minimum requirements are shown in the Table below.
- Destructive cut-outs and testing of production seams is not recommended for PTFE thermal welded seams due to the excessive patching and re-testing of destruct areas (refer to GRI GM 29). Trial Weld Destructs should be used for determining seam physical properties when required.

PROPERTY TEST	TEST METHOD	TEST RESULT AND LOB
Shear Strength	ASTM D 6392	14.0 N/mm (80.0 lb/in) BRK
Peel Strength	ASTM D 6392	4.38 N/mm (25.0 lb/in) SIP

2. Non-Destructive Test (NDT) Procedures

- Air Lance Test (ASTM D 4437)

- Inspect all field seams for unbonded areas using an air nozzle directed on the upper seam edge and surface to detect loose edges, riffles indicating unbonded areas within the seam, or other undesirable seam conditions.
- Check all bonded seams using a minimum 345 kPa (50 lb/in2) air supply directed through a 4.8 mm (0.188 in.) nozzle, held not more than 50.8 mm (2.0 in.) from the seam edge and directed along the seam edge.

3. **Non-Destructive Electrical Leak Location (ELL) in accordance with ASTM D 6747, D 7007 and D 7002.** Using the ELL method does not require routine destructive coupon cut-outs and testing. However, Trial Seam Coupon Testing is recommended to determine seam quality during production seaming. It should be noted that a electrically conductive geotextile may be required under the EverLiner™ 2130 for some sites when using the ELL method.

EverLiner™ 2130 Geomembrane Anchoring and Structure Terminations

1. Top Anchoring the Geomembrane

- The top of the slope should be rounded to provide a smooth transition for the liner to reduce stress. An anchor trench must be excavated around the entire perimeter of the impoundment. The excavated soil material can be placed next to the trench for backfilling after Geomembrane placement. The anchor trench should be a minimum of 3.0 ft back from the top of slope. The edge of the trench should be rounded and free of protrusions to reduce stress and damage on the Geomembrane.
- If soil movements are expected during filling of the containment, temporary anchoring should be provided at the crest so that the Geomembrane can move without being subjected to excessive tension. Partial ballasting in the anchor trench is provided, and final backfill is done at a later stage. To avoid movement and wind uplift of the Geomembrane during installation, temporary ballast (sandbags) is recommended.
- The Geomembrane must be kept in place to prevent down slope movement and/or wind uplift. Depending on the design requirements and potential for movement, the Geomembrane may be anchored at the top of the embankment (anchor trench), at the bottom, or at an intermediate bench.
- The top of slope anchor is commonly accomplished by burying the Geomembrane in a trench or by holding it in place through soil backfilling or ballasting.
- The Geomembrane should extend down the front (inside) of the trench wall and fully extend across the bottom of the trench.

2. Intermediate Anchors

- If the embankment is high and slopes are long, it is recommended to provide an intermediate bench at mid slope to accommodate the potential for Geomembrane movement. A bench may be added by the design engineer to provide slope stability of the embankment in addition to restricting downslope movement and allowing soil cover stability.
- The Geomembrane should be held in place by prefabricated ballast, anchor trench in the bench, or cover soil.

3. Toe of Slope / Bottom Ballast
4. In some cases, especially on larger containments, temporary and/or permanent ballast (soil cover) may be required due to operating conditions or wind conditions.
5. Inflow Areas
6. The point where the water or chemical stream enters the lined area must have proper termination as well as protection of the lining system. The area must be anchored against uplift and turbulence and must be protected by concrete or riprap as required in the design.

Structures and Pipe Penetrations

1. To avoid any differential settling, the backfill around the structures should be placed in successive layers, each compacted to 95% standard Proctor density.
2. Pipe connections can also be made by attaching the Geomembrane by flat run-on to a concrete collar that is cast around the pipe penetration. This is a preferable method to boots and an alternate to typical pipe boots (Refer to pipe attachment detail for concrete collars provided by the FGI or ASTM).
3. Bottom Drains, Pads, Structural Sections shall be mechanically fastened at the location of concrete structures (refer to typical concrete attachment details provided by the FGI or ASTM).

EverLiner™ 2130 Geomembrane Repair and Maintenance Procedures

1. A small tear or hole in the EverLiner™ 2130 Geomembrane may be repaired by placing a piece over the area to be repaired with 100 mm (4.0 in.) extending all directions beyond the repair. The patch must be round, oval, or contain rounded corners.

- Repair larger tears or holes by cutting a piece of Geomembrane that extends beyond the tear or hole by a minimum of 100 mm (4 in. extending all directions beyond the repair.

2. Annual maintenance inspection of the installation is recommended to detect any problems or potential problems. This inspection process will limit costs if damage has occurred. As a minimum, the following items should be included:

- Visual inspection of the Geomembrane, seams, and terminations.
- Measurement of any leakage rate at collection sump and monitoring of water level.
- Inspect all gas drainage vents for proper operation.
- Inspect for any historical or current overflowing of the containment.
- Inspect any cover materials for stability and movement that could damage the Geomembrane.
- Annual or periodic Electrical Leak Location Survey (ELLS) and repair of leaks found during the survey.

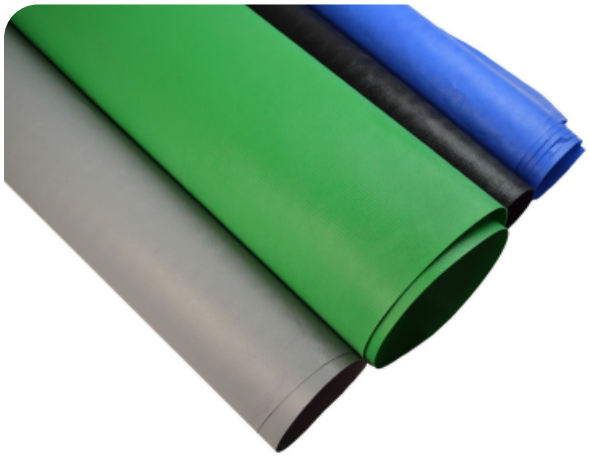
Protection of the EverLiner™ 2130 Geomembrane During Service

1. In service, protection of the Geomembrane will be required and should be designed by a professional engineer.
2. A detailed Operation and Maintenance Manual should be provided for inspection and repair for project lifetime.
3. Protection of the geomembrane may be realized in the following ways and must be designed by a professional engineer:

- Fully covered at all times by the liquid or waste product to be contained
- Fully covered by a soil, aggregate or concrete layer
- Partially covered side slopes only with soil, aggregate or concrete layer
- Protected from wind and wave action by ballast tubes

THE ONLY GEOMEMBRANE MATERIAL FOR LIFETIME CONTAINMENT

TCI's innovative EverLiner™ Geomembrane is a major breakthrough for corrosive containment and high temperature applications. Unlike competitive materials, this unique, 100% PTFE material is guaranteed to be corrosion free and will not contaminate the surrounding environment. EverLiner™ is effective against a variety of toxic and hazardous materials, including acid mine drainage (AMD) and red mud. It can be used in a temperature range of – 425°F to 600°F (-254°C to 316°C).



This rugged material has excellent tear and puncture resistance. EverLiner™ geomembranes can be heat-sealed in the factory prior to shipment. If damaged during installation, the material can be easily patched using a simple and quick sealing process. EverLiner™ is available in thicknesses ranging from 0.003" (0.076 mm) to 0.060" (1.52 mm).

For lifetime containment, use EverLiner™ Geomembrane.

EVERLINER™ - THE ULTIMATE BARRIER MATERIAL FOR EXTREME ENVIRONMENTS

- Guaranteed corrosion and contamination free
- 100% PTFE
- Temperature range of -425°F to 600°F (-254°C to 316°C)
- Compatible with all chemicals
- Unaffected by UV
- Unaffected by moisture
- Unlimited shelf life
- Non-flammable
- Heat-sealable
- Nonporous even after severe flexing

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