



HDPE GEOMEMBRANE LINER INSTALLATION GUIDE

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PART 1 - GENERAL

This installation guide describes the recommended requirements for the installation of high density polyethylene (HDPE) geomembrane liner. All procedures, operations and methods shall be in strict accordance with specifications, plans and approved engineering drawings.

1.1 QUALIFICATIONS

1.1.1 Installer

It is recommended that the Installer shall have at least five (5) years continuous experience in the installation of HDPE geomembrane liner and experience totaling 500,000m² of installed HDPE geomembrane liner for at least 10 completed projects.

1.1.1.1 It is recommended that installation shall be performed under the direction of a single installation supervisor, who shall remain onsite and be responsible throughout the liner installation for subgrade acceptance, liner layout, seaming, testing, repairs if necessary, and all other activities contracted by the installer. It is recommended that the installation supervisor shall have supervised the installation of at least 200,000m² of polyethylene geomembrane.

1.1.1.2 Welding should be performed under the direction of a lead fabricator who may be the same person as the installation supervisor, and is recommended to have a minimum of 100,000m² of polyethylene geomembrane welding experience using the same type of apparatus specified in this project. It is recommended that the installation supervisor and lead fabricator shall be onsite whenever welding is being performed.

1.2 QUALITY CONTROL

For the purpose of this installation guide, quality control shall be defined as a pre planned system of inspection and tests to directly monitor and control the quality of the installation. It is recommended that the installer shall employ a quality control inspector who may be the same person as the installation supervisor.

1.3 QUALITY ASSURANCE

For the purpose of this installation guide, quality assurance is defined as a pre planned system of activities carried out by the installer that provides assurance that the geomembrane liner was installed as specified. The quality assurance program may include tests similar to those carried out for quality control.

1.3.1 Design

1.3.1.1 **Proposed Layout:** It is recommended that the installer should produce drawings showing placement of liner and seams prior to installation. Any drawings should contain detailed descriptions of all methods of welding and patching the membrane, anchoring details, sealing at all penetrations and structures as shown on the approved issued to construction drawings.

1.3.1.2 **Record Drawings:** It is recommended that the Installer shall provide final "as installed" layout drawings to reflect any changes from the approved layout and details. As installed drawings should include the numbered identification and location of all seams, panels, and patches.

1.4 DELIVERY & STORAGE

During delivery and storage periods, the installer needs to protect geomembranes from mechanical damage, excessive mud & foreign debris. The liner should be placed on a smooth flat surface free of rocks. If required, a sand layer shall be placed in the storage area for added protection.

PART 2 - INSTALLATION

2.1 WELDING METHODS - EQUIPMENT

It is recommended that the installer shall follow the correct processes for seaming using double wedge fusion machines for general seaming and extrusion welding for patching. Proposed alternatives must be submitted for approval to the main contractor.

- 2.1.1 **Fusion Welding:** Welding should be completed using self propelled wedge welding apparatus. It is recommended that the apparatus should be equipped with gauges to monitor weld temperatures throughout the process. Weld temperature and machine speed shall be varied according to ambient conditions in order to maintain and demonstrate a consistent acceptable weld. All welding surfaces should be kept clean and dry at all times.
- 2.1.2 **Extrusion Welding:** Where needed seams shall be produced by extruding welding rod at the edge of two overlapped sheets of geomembrane to affect a homogeneous bond. It is recommended that the extrusion apparatus shall be equipped with gauges to monitor extrudate temperature. Temperature and flow rate shall be varied according to ambient conditions to maintain and demonstrate a consistent acceptable weld. The extruder shall be purged of all heat degraded material or cooled extrudate prior to the commencement of each seaming sequence.

2.2 THERMAL CONTRACTION

Compensation for thermal contraction of the geomembrane shall be provided as necessary during the liner installation as determined by the approved design.

2.3 SEAMING PROCEDURES

Where conditions warrant, the installer can use (if deemed necessary) a temporary support surface between the geomembrane and the subgrade to achieve proper support during the seaming operation. Seaming shall be a continuous process with a minimum of interruptions along any given seam. It is recommended that prior to seaming, the geomembrane shall be overlapped a minimum of 75 millimeters for extrusion welding and 100 to 150 millimeters for fusion welding. Any geomembrane area showing injury due to excessive scuffing, puncture, or distress from any cause shall, at the discretion of the installer's onsite supervisor, be repaired or replaced with an additional piece of geomembrane.

- 2.3.1 **Fusion Welding:** It is recommended that the membrane shall have an overlap of approximately 150mm. The area should be prepared by wiping the area with a clean dry cloth to remove any foreign matter. The welder shall be inserted at one end of the seam, then the pressure rollers are to be clamped down and the wedge engaged and drive motor turned on. If the welder is interrupted during the seaming process, the area affected shall be marked and repaired.
- 2.3.2 **Extrusion Welding:** It is recommended that the weld area shall be prepared by sanding or grinding to a depth of no more than .02 mm.. Grinding required along a seam shall be done concurrent with or within twenty minutes of the seaming operation and should not damage the geomembrane. It is recommended that membrane shall be overlapped a minimum of 75 millimeters prior to seaming. The weld area shall be kept clean and dry during this process at all times. Artificially induced cooling of extrusion welds, by water or any other means, shall not be allowed. Care should always be taken during vacuum testing that extrusion welds being vacuum tested are at ambient temperatures.
- 2.3.3 **Cross-seams:** It is recommended that the top and bottom excess overlap shall be removed and the top and bottom edge of the cross seam shall be ground to a smooth transition prior to seaming. If the cross seam is welded by means of fusion apparatus, the cross-seams should be cut back to the edge of the fusion weld and have a bead of extrusion applied 100 millimeters in all directions from the confluence of the two seams to form a "T". Seams should run parallel to any slopes.

2.4 COLD WEATHER SEAMING

Welding can be completed in colder temperatures provided guidelines are followed and the test welds are performed in the same environment as the main production seams. Test welds are very important, as they will verify that the welding equipment has been properly set to meet the onsite conditions. Below are some recommended additional guidelines to follow for the various temperature ranges..

Temperatures between 0.0C and -10.0C: The welding procedure is the same as warm weather procedures other than making slight adjustments to the welding units' temperature and/or speed. When the weather is clear and sunny and the wind is minimal, only very slight adjustments are required, but when it is cloudy, windy and cooler considerable adjustments may be required. Test welds should be performed to confirm settings are correct.

PART 3 - QUALITY CONTROL

3.1 QUALITY CONTROL - INSTALLATION

3.1.1 Site Test Equipment

It is recommended that the installer should maintain onsite, in good working order, the following items:

- 3.1.1.1 **Field Tensiometer:** The ensiometer should be a load certified motor driven unit and have jaws capable of traveling at a measured rate of 50 millimeters/min. The tensiometer should be equipped with a gauge which measures units of force exerted between the jaws. Calibration of the unit shall have been performed within twelve months of the installation date.
- 3.1.1.2 **Vacuum Box:** The vacuum box should consist of a rigid housing with a transparent viewing window on top and a soft, closed-cell neoprene gasket attached to the bottom of the housing. The housing should be equipped with a bleed valve and a vacuum gauge capable of reading in tenths of a bar. A separate vacuum source shall be connected to the vacuum box such that a negative pressure can be created and maintained inside the box. A "soapy" solution consisting of soap and water should be dispensed on the seam immediately ahead of the vacuum box.
- 3.1.1.3 **Air Pressure Test Equipment:** TThis method should only apply when the split wedge seaming method is used. Equipment shall consist of an air pump capable of generating and maintaining a positive pressure of between 1.5 to 2.0 bars. A manometer capable of reading up to 2.0 bars attached to a needle or nipple shall be used to pressurize the air channel in the seam.

3.1.2 Non-Destructive Testing

- 3.1.2.1 **Test Seams (Start-up):** It is recommended that test seams should be made to verify that adequate conditions exist for field seaming to proceed. Each seaming apparatus shall produce a test seam at the beginning of each shift. In addition, if a seaming operation has been suspended for more than four hours or if a breakdown of the seaming equipment occurs, a test seam shall be produced prior to resumption of seaming operation. Test seams shall be made in the field on pieces of the approved geomembrane. It is recommended that each test seam shall be at least 1.5 meters long by 300 millimeters wide for extrusion and 3 m long by 300 millimeters wide for fusion, with sufficient overlap for peel testing in the field tensiometer. Two samples 25 millimeters wide shall be taken from each end of the test seam using an approved template. The samples shall be tested in the field tensiometer, one from each end in peel and shear respectively. Samples tested in peel should not fail in the seam. If the seam fails, the seaming apparatus shall not be used for field seaming until any deficiencies have been identified and corrected. This shall be verified by the production and successful testing of another test seam.

PART 3 - QUALITY CONTROL CONTINUED

3.1 QUALITY CONTROL - INSTALLATION CONTINUED

3.1.2 Non-Destructive Testing

3.1.2.2 **Vacuum Testing:** It is recommended that all extrusion welded seams and "T" Seams should be evaluated using vacuum box testing. A "soapy" solution shall be applied to the test section and the vacuum box placed over the section. The bleed valve is closed and the vacuum valve opened. The vacuum box shall maintain at least 0.2 bar vacuum during the test. Once a tight seal has been established, the test section shall be visually examined for a period of not less than 10 seconds to determine whether bubbling of the soapy solution at the seam is occurring. The vacuum box is then moved and the process is repeated on the next adjacent section. A minimum of 25 millimeters overlap shall be provided between all test sections. All locations where bubbling of the sudsy solution is observed shall be clearly marked for repairs with a high visibility marker and recorded by number on field test reports. Any failed portion of seam shall be repaired and retested.

3.1.2.3 **Air Pressure testing:** Double wedge welded seams should be sealed off at both ends. If the end of a seam will be an integral part of the geomembrane, the sealing shall be done in such a way that it does not harm the future function of the geomembrane. The pressure feed device shall be inserted into the air channel at one end of the seam and pressurized to a minimum 2.0 bars. The feed valve shall be closed and the pressure sustained for a period of not less than 60 seconds. The pressure shall then be released by splitting the air channel at the opposite end of the seam. The QA inspector / operator should observe the drop in pressure on the manometer to verify the continuity of the air channel. If a pressure loss of greater than 0.2 bars is observed or if the required pressure cannot be reached, then the seam shall be rejected, and shall be either reconstructed in its entirety or the leak located and patched. The entire seam shall then be retested according to the procedure outlined above.

3.1.2 Non-Destructive Testing

3.1.2.4 It is recommended that all seams should be non-destructively tested by the Installer over the full length of weld to verify the integrity of the seam. Non-destructive testing shall be performed concurrently with field seaming.

3.1.3 Destructive Testing

3.1.3.1 It is recommended that destructive testing of field seams should be performed at selected locations in order to verify seaming properties. All sampling and testing shall be done concurrently with field seaming so that verification of field seam properties is made as the work progresses and corrective action implemented, if necessary.

3.1.3.2 It is recommended that test samples should be taken at an average frequency of one test location per 150 meters of seam. Sample locations shall be determined by quality assurance taking into consideration the difficulty of subsequent repair and testing.

3.1.3.3 Samples shall be cut by the installer under the direction of the quality assurance. Each sample shall be indelibly numbered and identified. The sample number and location shall be recorded by quality assurance.

3.1.3.4 Quality assurance may decrease or increase the amount of destructive testing based on the results of previous testing. Additional samples may also be required when quality assurance have reason to suspect the presence of excess crystallinity, contamination, faulty seam quality.

3.1 QUALITY CONTROL - INSTALLATION CONTINUED

3.1.3 Destructive Testing

- 3.1.3.5 It is recommended that test samples shall measure approximately 300 millimeters wide by 1.0 meter long with seam entered lengthwise along the sample. It is recommended that ten number 2.5 cm wide sample strips should be tested in the presence of quality assurance.
- 3.1.3.6 The area from which the destructive test sample was taken should be repaired without delay and shall be non-destructively tested by vacuum box.

3.1.4 Inspection and Acceptance

- 3.1.4.1 It is recommended that as the work progresses, quality assurance documents all locations requiring repair work and shall verify and document that all repairs have been successfully made.
- 3.1.4.2 Seams are only considered to be accepted after they have passed the specified non-destructive and destructive tests, and the equipment used to produce the seams have passed the recommended start-up tests. If a seam fails the above criteria, the installer must reconstruct the seam.
- 3.1.4.3 It is recommended that the entire geomembrane surface should be examined by quality assurance to confirm that it is free of any defects, holes, blisters, undispersed raw materials, or contamination by foreign matter. The geomembrane surface shall be cleaned by the installer, if required, so that it is free of dust, mud, debris or any other material which may inhibit a thorough examination of the surface. Any suspect areas should be clearly marked and non-destructively tested according to the appropriate specified testing procedure.

PART 4 - COMPLETION OF WORK

4.1 REQUIREMENTS

The installation of the HDPE geomembrane shall be considered complete when all required deployment, seaming, repairs, testing and site clean-up, have been completed by the installer. The Installer must submit all the required certifications and test records to the main contractor.

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