HDPE Installation Manual

A Containment Information Report

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Part 1 - General

1.1 Scope

These specifications describe the requirements for the manufacture, supply and installation of polyethylene geomembrane. All procedures, operations and methods shall be in strict accordance with specifications, plans and engineering drawings.

1.2 Requirements

- Furnish and install HDPE liner.
- Quality Control all liner and extrusion materials supplied to the job site.
- Quality Control all aspects of the liner installation including attachments to structures and penetrations.
- Furnish all drawings and reports required in this Section.

This specification refers to the following Standards, Specifications or Publications:

**ASTM D 5641**: Standard Practice for Geomembrane Seam Evaluation by Vacuum Chamber

**ASTM D 5820**: Standard Practice for Pressurized Air Channel Evaluation of Dual Seamed Geomembranes

**ASTM D 6392**: Standard Test Methods for Determining The Integrity of Non-Reinforced Geomembrane Seams Produced Using thermo Fusion Methods

**ASTM D 7240**: Standard Practice for Leak Location using Geomembranes with an Insulating layer in Intimate Contact with a Conductive Layer via Electrical Capacitance Technique (Conductive Geomembrane Spark test)

**GRI Test Method GM 9**: Standard Practice for Cold Weather Seaming of Geomembranes

**GRI Test Method GM13**: Test Properties, Testing Frequency and Recommended Warranty for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes

**GRI Test Method GM14**: Selecting Variable Intervals for taking Geomembrane Destructive Seam Samples Using the Method of Attributes

1.3 Qualifications

1.3.1 Manufacturer

The manufacturer of the geomembrane sheet shall be approved by the Owner and have satisfactory experience in extruding polyethylene materials and a reputation for producing a high quality product.

1.3.2 Installer

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

1.3.2.2 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, and repairs, and all other activities contracted by the Installer. The installation supervisor shall have supervised the installation of least 200,000 m² of polyethylene geomembrane.

1.3.2.3 Actual seaming shall be performed under direction of a master seamer who may be the same person as the installation supervisor, and who has a minimum of 100,000 m² of polyethylene geomembrane seaming experience using the same type of seaming apparatus specified in this project. The installation supervisor and master seamer shall be onsite whenever seaming is being performed.

1.3.2.4 The Installer shall be an approved installer by the Manufacturer of the Geomembrane.

1.4 Quality Control

For the purpose of this specification, quality control shall be defined as a planned system of inspection and tests to directly monitor and control the quality of the work. The Contractor shall employ a quality control inspector who may be the same person as the installation supervisor.

1.5 Quality Assurance

For the purpose of this specification, quality assurance is defined as a planned system of activities carried out by the Owner or his Representative that provides assurance that the geomembrane liner was constructed/installed as specified. The quality assurance program may include tests similar to those carried out for quality control. The Contractor shall assist and cooperate with the Owner's Representative or the Engineer in the execution of the quality assurance program.

1.6 Submittals

Prior to inspection and delivery of the geomembrane to the work site, the Installer shall submit the following to the Engineer for approval. Work shall not commence until the Engineer has all of the following in his possession:

1.6.1 Resin Manufacturer's Certificates

1.6.1.1 Written certification that the product delivered was extruded form the specified resin including the following information:

The origin of the resin: Resin Supplier's name, resin production plant, brand name, number and production date of the resin;

A copy of the quality control certificate issued by the Resin Supplier
1.6.2 Geomembrane Manufacturer's Certificates

1.6.2.1 Geomembrane manufacturer's certificates for each shift's production of geomembrane. Quality control certificates shall be signed by responsible parties employed by the Manufacturer. No geomembrane will be permitted to be delivered until the Engineer has in his possession the following information:

- Roll numbers and identification;
- Sampling procedures and results to quality control tests;
- Extrusion pellets or rod shall be certified by the Manufacturer that it is made of the same resin as the parent geomembrane supplied as in Section 2.2.
- Installation and erection data and schedule;
- Manufacturer's standard warranty;
- Include resumes of all technical personnel who will perform work on the liner installation.

1.6.3 Shop Drawings showing the following:

1.6.3.1 Proposed Panel Layout: The Installer shall produce drawings showing placement of panels and seams prior to installation, and their numbered sequence, as well as areas for adding material for thermal compensation. Included shall be drawings and detailed descriptions of all methods of welding and patching the membrane, anchoring details, sealing at all penetrations and structures shown on the approved plans.

1.6.3.2 Record Drawings: The Installer shall provide final "as recorded" layout drawings to reflect any changes form the proposed panel layout and details. As-built drawings shall include the numbered identification and location of all seams, panels, and patches.

1.7 Delivery & Storage

During delivery and storage, protect geomembranes from mechanical damage, excessive mud & debris. Liner should be placed on a smooth flat surface free of rocks. If required, a sand layer shall be place in the storage area.

1.8 Basis of Payment

Payment for this Section shall be included in the items listed in the Form of Tender unless specified separately.

1.9 Schedule of Work

Submit schedule of expected work for approval by the Engineer including means and methods of installation.
Part 2 - Materials

2.1 Acceptable Geomembranes

High density polyethylene geomembrane manufactured by GSE Lining Technology Inc. or Solmax International and installed by Nilex Construction Inc.

2.2 Properties HDPE Geomembrane

The geomembrane shall be manufactured form new first quality polyethylene resin of the type specified in this document. Polyethylene geomembrane shall meet all requirements for the specified end use. Reclaimed polymer shall not be added to the resin except the polymer recycled during the manufacturing process. Recycled polymer shall not exceed 2% by weight. The sheet geomembrane shall demonstrate the typical properties shown on the manufacturer’s specification sheet.

2.3 Documentation

Prior to delivery of the geomembrane to the job site, the Installer shall be required to provide the Owner with a written certification that the product delivered was extruded from a resin that meets minimum properties listed on the Manufacturers quality control certificates. The manufacturer of the geomembrane shall provide quality control certificates for each batch of resin and each shift's production of geomembrane, and shall follow the quality control testing program as described in Section 1.5. These quality control certificates shall be signed by responsible parties employed by the manufacturer, and shall be supplied to the Owner or his Representative. No geomembrane will be permitted to be delivered until the Owner has in his possession such certification.

2.3.1 Testing of lining materials prior to delivery: Lining materials proposed to be used on the project shall be set aside by the manufacturer, complete with certificates. Each roll of geomembrane and extrusion rod shall be marked as specified in Section 2.3.4 and the following information shall accompany the certificates:

- Thickness: ASTM D 75, NSF Mod.
- Density: ASTM D 792
- Melt Flow Index: ASTM D 1238, Con. E. Max.
- Tensile Properties: ASTM D 638
- Tear Resistance: ASTM D 1004
- Puncture Resistance: ASTM FTMS 101, Method 2065

2.3.2 Roll Identification: Each roll shall have permanently affixed and accessible inside the core the following information: name of manufacturer; date of manufacture; thickness of the material; roll number; roll length; and roll width.

2.3.3 Transportation: Transportation shall be the responsibility of the Installer. Any damaged or unacceptable material shall be replaced by the Installer at no cost to the Owner.

2.3.4 Storage: Once on site, storage of the geomembrane shall be the responsibility of the Contractor. The geomembrane shall be stored to avoid deformation of rolled goods from one place to another.
Part 3 - Installation

3.1 Seaming Methods –Equipment

Approval processes for seaming are *double wedge fusion welding* for general seaming and *extrusion welding* for patching. Proposed alternatives must be submitted for approval to the Owner or his Representative.

3.1.1 Fusion Welding: The seam shall be produced by self propelled wedge welding apparatus. The apparatus shall be equipped with gauges to monitor weld temperature. 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 shall be kept clean and dry.

3.1.2 Extrusion Welding: The seam shall be produced by extruding molten resin at the edge of two overlapped sheets of geomembrane to affect a homogeneous bond. 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 or cooled extrudate prior to the commencement of each seaming sequence.

The Installer shall maintain at least one spare operable seaming unit of each type onsite at all times.

3.2 Panel Deployment

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

3.3 Seaming Procedures

Where conditions warrant, the Installer shall be allowed to use 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. 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.

3.3.1 Fusion Welding: The membrane shall have an overlap of approximately 150mm. The area shall 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.

3.3.2 Extrusion Welding: The weld area shall be prepared by sanding or grinding to a depth of less than .02 mm in the sheet surface to be in contact with the extrudate. Grinding required along a seam shall be done concurrent with or within twenty minutes of the seaming operation and shall not damage the geomembrane. Membrane shall be overlapped a minimum of 75 millimeters prior to seaming. The weld area shall be kept clean and dry during this process. Installer shall determine when preheating of the area to be seamed is required. Artificially induced cooling of extrusion welds, by water or any other means, shall not be allowed. Care shall be taken during vacuum testing that extrusion welds being vacuum tested are at ambient temperatures.
3.3.3 **Cross-seams**: 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 shall still 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 shall run parallel to the slope.

### 3.4 Cold Weather Seaming

Welding can be completed in colder temperatures provided some additional guidelines are followed and the trial welds be performed in the same environment as the main production seams. The trial welds are very important, as they will verify that the welding equipment has been properly set to meet the site conditions. Below are some of additional guidelines to follow for the various temperature ranges. The onsite superintendent shall also have the experience to determine whether or not satisfactory seams can be achieved given the weather and site conditions and what steps need to be taken in order to obtain a satisfactory seam. Temperatures between 0°C and -10°C: 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. Temperatures between -10°C and -20°C+: Additional care must be taken to ensure that the welding units are operating properly in the cold and that the welding temperatures and speeds are adjusted to accommodate the colder temperatures. During the seaming operation, the technician will monitor the welding unit to ensure that the set welding speeds and temperatures are maintained throughout the length of the seam. Depending on the weather conditions (cloudy, windy, frosty, etc.) the seam area may require preheating, with space heaters or hot air guns, to ensure a satisfactory weld is obtained. No welding can take place when it is raining; sleeting, snowing or moisture of any type is present. Extra care must be taken when working on a wet, icy or snowy liner, as the liner becomes very slippery under these conditions. Removal of snow & ice can be completed using rubber tired snow blowers and plastic shovels.

## Part 4 - Quality Control

### 4.1 Quality Control - Installation

#### 4.1.1 Site Test Equipment

The Installer shall maintain onsite, in good working order, the following items:

4.1.1.1 **Field Tensiometer**: The tensiometer shall be a load certified motor driven unit and have jaws capable of traveling at a measured rate of 50 millimeters/min. The tensiometer shall be equipped with a gauge which measures units of force exerted between the jaws. Certification of the unit shall have been performed within twelve months of the installation date.

4.1.1.2 **Vacuum Box**: The vacuum box shall 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 shall 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 sudsy solution consisting of soap and water shall be dispensed on the seam immediately ahead of the vacuum box.

4.1.1.3 **Air Pressure Test Equipment**: This method shall apply only when the split hot 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.
4.1.2 Non-Destructive Testing

4.1.2.1 Test Seams (Start-up): Test seams shall 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. 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 shall not fail in the seam. All test samples shall exhibit film tear bond and strength as defined under seam properties shown on page 10, table 1. If the seam fails, the seaming apparatus shall not be used for field seaming until any deficiencies have been corrected. This shall be verified by the production and successful testing of another test seam.

4.1.2.2 Vacuum Testing: All extrusion welded seams and "T" Seams shall be evaluated using vacuum box testing. A sudsy soap solution shall be applied to the test section and the vacuum box placed over the section. The bleed valve is the 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.

4.1.2.3 Air Pressure testing: Double wedge welded seams shall 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 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 slitting the air channel at the opposite end of the seam. The Inspector shall 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.

4.1.2.4 For spark testing, a conductive geomembrane is required. The procedure for this method will be ASTM D 7240, unless otherwise approved by the Owner/engineer.

4.1.2.5 All seams shall be non-destructively tested by the Installer over their full length to verify the integrity of the seam. Non-destructive testing shall be performed concurrently with field seaming. All non-destructive testing shall be observed and documented by the Inspector.
4.1.2.6 Approved non-destructive testing procedure is as above. Alternate procedures shall be submitted for approval to the Owner or his Representative prior to the commencement of non-destructive testing.

4.1 Destructive Testing

4.1.3 Destructive testing of field seam shall 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.

4.1.3.1 Test samples shall be taken at an average frequency of one test location per 150 meters of seam. Sample locations shall be determined by the Inspector taking into consideration the difficulty of subsequent repair and testing. The Installer shall not be informed in advance of the locations where the seam samples will be taken.

4.1.3.2 Samples shall be cut by the Installer under the direction of the Inspector. Each sample shall be indelibly numbered and identified. The sample number and location shall be recorded by the Inspector.

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

4.1.3.5 The test sample shall measure approximately 300 millimeters wide by 1.0 meter long with seam entered lengthwise along the sample. Ten 2.5 cm wide sample strips shall be tested in the presence of the Engineer in the inspector tensiometer, 5 in peel and 5 in shear and shall meet the criteria listed below. The remainder of the sample and all test strips shall remain the property of the Owner.

<table>
<thead>
<tr>
<th>Geomembrane Nominal Thickness</th>
<th>30 mils</th>
<th>40 mils</th>
<th>50 mils</th>
<th>60 mils</th>
<th>80 mils</th>
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<td>Hot Wedge Seams(1)</td>
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<tr>
<td>shear strength(2), lb/in.</td>
<td>57</td>
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<td>100</td>
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<td>240</td>
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<td>50</td>
<td>50</td>
<td>50</td>
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<tr>
<td>peel strength(2), lb/in.</td>
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<td>60</td>
<td>76</td>
<td>91</td>
<td>121</td>
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<tr>
<td>peel separation, %</td>
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<td>25</td>
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<td>Extrusion Fillet Seams</td>
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<td>shear strength(2), lb/in.</td>
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<td>100</td>
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<td>shear elongation at break(3), %</td>
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Notes:
1. Also for hot air and ultrasonic seaming methods
2. Value listed for shear and peel strengths are for 4 out of 5 test specimen; the 5th specimen can be as low as 80% of the listed values
3. Elongation should be omitted for field testing

The Owner, at his option, may send the remaining sample to a lab of his choice for further destructive testing and approval. In any event, the samples shall not be considered to pass the test until the Engineer and Inspector are satisfied that the meet the seam pass/fail criteria of film tear bond and minimum seam properties.

4.1.3.6 The area from which the destructive test sample was taken shall be repaired without delay and shall be non-destructively tested by vacuum box as described in Section 4.1.2.2.
4.1.4 Inspection and Acceptance

4.1.4.1 As the work progresses, the Inspector shall document all locations requiring repair work and shall verify and document that all repairs have been successfully made by the Installer. No work on the liner shall be allowed if the inspector is not present. This is to include start-up tests, general seaming and patching, and any work at penetrations or structures.

4.1.4.2 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 required start-up tests. If a seam fails the above criteria, the Installer must reconstruct the seam.

4.1.4.3 The entire geomembrane surface shall be examined by the Inspector 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 shall be clearly marked by the Inspector and non-destructively tested according to the appropriate specified testing procedure.

4.1.4.4 Overburden shall not be applied to any portion of the liner system until that portion system is inspected by the contractor and the engineer and all documents affecting that portion have been approved.

Part 5 - Completion of Work

5.1 Requirements
The installation of the geomembrane shall be considered totally complete when all required deployment, seaming, repairs, testing and site clean-up, including sand bags have been completed by the Installer; the Installer has submitted all the required certifications to the Owner; and the Owner and/or his Representative is satisfied that the geomembrane has been installed in accordance with the above Specifications.

5.2 Installation Warranty
The Installer shall guarantee the HDPE membrane against defects in installation and workmanship for the period of one year commencing with the date of final acceptance of the liner system.

5.3 Material Warranty
The HDPE membrane manufacturer shall warrant the membrane against manufacturing defects for a period of x years from the date of installation. The manufacturer shall furnish the Owner with a written warranty covering the requirements of this paragraph.
Appendix A:
Quality Control Documents
### WEDGE WELDER QUALIFICATION

<table>
<thead>
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<th>SAMPLE NUMBER</th>
<th>TIME</th>
<th>MACHINE NUMBER</th>
<th>MACHINE TEMP (°F)</th>
<th>SPEED (ft/min)</th>
<th>TECH</th>
<th>Peel / Separation</th>
<th>Shear</th>
<th>Pass/Fail</th>
<th>met Welded</th>
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- **sm-smooth**
- **tex-textured**

QC Technician ___________________

QA/QC Approval ___________________
## Extrusion Welder Qualification

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<th>PROJECT #</th>
<th>PROJECT MATERIAL</th>
<th>QC</th>
<th>OWNER</th>
<th>CONTRACTOR</th>
<th>ENGINEER</th>
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- Nilex Construction Inc.
- 9304-39 Avenue
- Edmonton, Alberta
- T6E 519
- PH: (800) 857-4811
- FAX: (780) 453-1773

- Nilex

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Nilex.com

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<table>
<thead>
<tr>
<th>Panel Number</th>
<th>Roll Number</th>
<th>Installation Date</th>
<th>Dimensions (ft)</th>
<th>Area (sqft)</th>
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<td>width</td>
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Total: 0.00

QC Technician: ___________________________

QC Approval: ___________________________
# Destructive Sample

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<th>DT #</th>
<th>SEAM NUMBER</th>
<th>DATE WELDED</th>
<th>DATE TESTED</th>
<th>MACHINE NUMBER</th>
<th>TECH</th>
<th>Peel / Separation</th>
<th>Shear / Elongation</th>
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sm-smooth
tex-textured

QC Technician __________________________
QA/QC Approval __________________________
## Seam Pressure Testing Log

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<th>Project #</th>
<th>Project Material</th>
<th>Owner</th>
<th>Contractor</th>
<th>Engineer</th>
<th>QC</th>
<th>QC Tech</th>
<th>Comment</th>
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<tbody>
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<td>Date</td>
<td>Test Date</td>
<td>Time</td>
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<td>Finish</td>
<td>QC Tech</td>
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Nilex Construction Inc.
9304-39 Avenue
Edmonton, Alberta
T6E 5T9
PH: (800) 667-4811
FAX: (780) 463-1773
# End Seam Sample Log

**Nilex Construction Inc.**

9304-39 Avenue  
Edmonton, Alberta  
T6E 5T9  
PH: (800) 667-4811  
FAX: (780) 463-1773

**PROJECT #**  
**OWNER**  
**PROJECT**  
**CONTRACTOR**  
**MATERIAL**  
**ENGINEER**  
**QC**

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<th>Peel Out</th>
<th>Shear</th>
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QC Technician  
QC/QC Approval