

**QUALITY ASSURANCE PLAN FOR
FABRICATION / INSTALLATION OF
30 MIL ANTISKID POLYETHYLENE
GEOMEMBRANE LINERS**



Colorado Lining International, Inc.
Parker, CO 80138
(800) 524-8672/(303) 841-2022
Fax: (303) 841-5780
www.coloradoining.com

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|--|----|
| PART I PURPOSE | 3 |
| 1.1.0 Scope of Quality Assurance..... | 3 |
| 1.2.0 Units..... | 3 |
| 1.3.0 References | 3 |
| PART II FABRICATION..... | 3 |
| 2.0 FACTORY FABRICATION AND QUALITY CONTROL..... | 3 |
| 2.1.0 Roll goods material testing..... | 3 |
| 2.2.0 Fabrication (in factory welding)..... | 3 |
| 2.3.0 Thermal welding method..... | 3 |
| 2.4.0 Extrusion Welder Seaming Procedure | 4 |
| 2.5.0 In-Factory seam testing and requirements..... | 4 |
| 2.6.0 Panel layout placement drawings | 4 |
| PART III DELIVERY | 4 |
| 3.1.0 Transportation and Handling..... | 4 |
| 3.2.0 Storage | 5 |
| 3.2.1 Special Consideration for Welding Rod or GCL Liner | 5 |
| PART IV SITE PREPARATION & INSPECTION..... | 5 |
| 4.1.0 Anchor Trench Systems | 5 |
| 4.2.0 Site Inspection | 5 |
| PART V PANEL DEPOLYMENT AND TRACKING..... | 6 |
| 5.1.0 Weather and Site Conditions..... | 6 |
| 5.2.0 Panel Identification | 6 |
| 5.3.0 Panel Placement..... | 6 |
| 5.4.0 Precautions during Panel Placement | 6 |
| 5.5.0 Damaged Material | 7 |
| PART VI SEAMING..... | 7 |
| 6.1.0 Required Weather Conditions for Seaming | 7 |
| 6.2.0 Seaming and Related Equipment..... | 7 |
| 6.2.1 Equipment Preparation | 7 |
| 6.2.2 Trial Seams..... | 8 |
| 6.3.0 Seam Layout | 8 |
| 6.4.0 Panel Overlap for Seaming | 8 |
| 6.5.0 Seam Preparation..... | 9 |
| 6.6.0 Wedge Welder Seaming Procedure | 9 |
| 6.7.0 Extrusion Welder Seaming Procedure | 10 |
| PART VII NON-DESTRUCTIVE SEAM CONTINUITY TESTING | 10 |
| 7.1.0 Vacuum Box Testing..... | 10 |
| 7.2.0 Air Channel Pressure Testing | 11 |
| 7.2.1 Pressure Test Failure | 11 |
| 7.3.0 Mechanical Point Stressing..... | 12 |
| PART VIII DESTRUCTIVE SEAM TESTING | 12 |
| 8.1.0 Sample and Coupon Size and Extraction | 12 |
| 8.2.0 Coupon Field Testing | 12 |
| 8.3.0 Procedures for Test Failure | 13 |
| PART IX DEFECTS AND REPAIRS | 13 |
| 9.1.0 Identification | 13 |
| 9.2.0 Repair Procedures..... | 14 |
| 9.2.1 Verification of Repairs | 14 |
| PART X ANCILLARY ITEMS AND FINAL ACCEPTANCE..... | 14 |
| 10.1.0 Pipe Penetrations | 14 |
| 10.2.0 Backfilling of Anchor Trenches | 14 |
| 10.3.0 Lining System Acceptance | 15 |

PART I PURPOSE

This manual addresses the quality assurance and quality control of the fabrication and installation of Linear Low Density Polyethylene (LLDPE) geomembrane liners used by Colorado Lining Construction (CLC) in hazardous waste disposal landfills, surface impoundments or other installations as specified by the owner and/or engineer. This manual delineates the quality procedures and standards for installation.

1.1.0 Scope of Quality Assurance

The scope of this manual includes the quality assurance applicable to shipment, handling, and installation of Low Density Polyethylene (LLDPE) geomembrane liners also referred to Flexible Membrane Liners (FML's).

1.2.0 Units

In this manual, all properties and dimensions are expressed in English units, with "equivalent" Système International (SI)/metric units in parentheses. It should be noted that the conversion is typically only accurate within ten percent. In cases of conflict or clarifications, the U.S. units shall be deemed to govern. Since most field geomembrane testing equipment manufactured in the United States are equipped to measure in English units, required test result data are tabulated herein with such units.

1.3.0 References

The manual includes references to test procedures of the American Society for Testing and Materials (ASTM), the Federal Test Method Standards (FTMS) and the "Standards for Flexible Membrane Liners" of the National Sanitation Foundation (NSF).

PART II FABRICATION

2.0 FACTORY FABRICATION AND QUALITY CONTROL

2.1.0 Roll goods material testing

The Manufacturer of the liner material shall provide certification to the Fabricator that the material meets minimum property values per attached specification. Any lot of materials that does not meet this specification will be rejected by the Fabricator. The Fabricator may spot check the certified values. This audit may be conducted according to the procedures as specified in the Fabricator's quality control documents.

2.2.0 Fabrication (in factory welding)

LLDPE geomembranes sheets are typically 25' wide and are transported in rolls either c-folded or w-folded. The rolls are welded together and tested for seam integrity by the Fabricator before going to the job site. The factory welding can be performed in two different ways.

2.3.0 Thermal welding method

The thermal method works on the principle of using heat to melt the interface surface of the two sheets being fused. Pressure is applied to assist with the fusion. The heat source can be provided by a wedge or hot air.

2.4.0 Extrusion Welder Seaming Procedure

Using a hot air welder or hand held heat gun with seam roller the overlapping materials to be welded must first be pre-bonded to hold the materials in place before actual extruding. Welding operations should be observed to assure that the machines are properly aligned resulting in weld beads that are centered over the edges of the top FML sheets and that weld bead appearances are smooth and uniform.

2.5.0 In-Factory seam testing and requirements

Before any welding is performed by either method on the actual membrane lining system, trial seam welds must first be performed yielding passing results.

CLC shall prepare trial seams made with test strips of the actual membrane being installed to verify that seaming conditions are adequate. Such trial seams shall be made at the beginning of each seaming period (start of the day and midday) for each seaming apparatus used. Trial seams shall be made under the same conditions as actual seams.

The trial seam sample shall be approximately 3 feet/1.0 m long by 1 foot/0.3 m wide (after seaming) with the seam centered lengthwise. Seam overlap shall be nominally 4 inches/10.2 cm, 3 inches/7.6 cm minimum.

Unless otherwise specified, four (4) seam sample coupons each measuring 1"/25mm wide x 6"/150mm long shall be cut from the trial seam sample in increments to span it's length. The specimens shall be tested in peel (2 ea.) and shear (2 ea.) modes using a tensiometer. In the event of a failed trial seam no seaming apparatus shall be used for seaming until deficiencies are corrected and a successful trial weld has been achieved.

All data should be recorded on the Plant QA form for each individual panel. This form is a complete map and test data record for each panel. Available upon request to the engineer, GC or owner at any time.

2.6.0 Panel layout placement drawings

The proposed panel layout placement diagrams will be provided to the Engineer and/or the Owner by the Installer prior to material being delivered to the job site. The proposed panel placement should show seam direction and panel sizes drawn to scale.

Placement of the LLDPE liner will not begin until the proposed panel layout diagram has been approved by the Engineer/Owner, including changes made at the job site.

Each panel should be given an identification number or letter and labeled with the size of the panel. This information is put on both the finished panel and on the outside of the packaging. This helps to ensure proper placement of the panel during deployment.

PART III DELIVERY

3.1.0 Transportation and Handling

CLC through its own transportation or an independent trucking firm or other party as agreed upon by the Owner will perform transportation of the geomembrane. If the geomembrane arrives on site prior to CLC project personnel, the Owner is responsible for off-loading roll goods and any ancillary items shipped. The material received shall be matched against the freight bill of lading. Any discrepancies shall be immediately reported to CLC before the shipment is signed for. When off-loaded, geomembrane and any ancillary items should be placed on a smooth, well drained surface, free of rocks or any other protrusions which may damage the material. No special covering is necessary for geomembrane.

The following should be verified prior to and during off-loading geomembrane:

Handling equipment used on the site is adequate and does not pose any risk or damage to the geomembrane and that personnel handle the geomembrane with care. If slings are provided, the material should be lifted with such. In any event, materials shall be offloaded in a safe manner whereby the rolls are properly balanced and no personnel or property are at risk of being injured/damaged should loss of control of any roll(s) of material occur.

Upon arrival at the site, CLC shall conduct a surface observation of all rolls for defects and for damage. This inspection shall be conducted without unrolling rolls unless defects or damages are found or suspected. CLC shall indicate any damage to the Owner's Representative. The Owner shall immediately report to CLC any damage known to exist prior to delivery or that may have occurred during off-loading/handling.

3.2.0 Storage

The Owner shall provide storage in location (or several locations) such that on-site transportation and handling are minimized. Storage space should be protected from theft, vandalism, passage of vehicles, and be adjacent to the area to be lined.

3.2.1 Special Consideration for Welding Rod or GCL Liner

Should any welding rod or clay (GCL) liner be delivered to the site prior to CLC arrival, such materials shall be immediately secured in a sheltered/dry condition and maintained in such condition until deployed by CLC personnel.

PART IV SITE PREPARATION & INSPECTION

4.1.0 Anchor Trench Systems

All Anchor Trench Systems shall be excavated by others (unless otherwise specified) to the lines and widths shown on the design drawings, prior to geomembrane placement.

4.2.0 Site Inspection

Immediately prior to installation, the subgrade shall be jointly inspected and walked by the Owner's Representative and CLC personnel to determine its worthiness to accept the specified lining system. The decision to repair cracks, if any, should be made only by the Owner's Representative. Once properly prepared, CLC will sign acceptance of the surface condition of the subgrade. The integrity of the underlying soil shall remain the responsibility of the owner/earthwork contractor.

Subgrade Preparation Recommendations:

No liner shall be placed on surfaces not previously found acceptable by the CLC supervisor or his agent.

Surfaces to be lined shall be compacted, smooth, and free of all rocks greater than 3/8" in diameter, sharp angular stones, sticks, vegetation, roots, sharp objects, gravel, or debris of any kind. The surface shall provide a firm, unyielding foundation for the lining system with no sudden, sharp or abrupt changes or breaks in grade or geometry.

Part V PANEL DEPLOYMENT AND TRACKING

5.1.0 Weather and Site Conditions

Panel placement shall not take place during precipitation, or in the presence of excessive winds (unless wind barriers are provided). In addition, deployment shall not take place in any areas of ponded water.

5.2.0 Panel Identification

Panels are portions of roll stock membrane that are field cut to size as required for fitment and overlapped/welded in situ. In larger projects, a panel may consist of an entire uncut roll.

At the time of installation, the CLC Field Supervisor shall give each field panel an "identification code" (Number or letter-number). This field panel identification code shall be as simple and logical as possible.

5.3.0 Panel Placement

Panels are located by the CLC Field Supervisor in a manner consistent with the Specification and best suited to existing site conditions. Field Panels shall be placed one at a time and each shall be seamed immediately after its placement for protection against wind action or rainwater infiltration.

CLC shall record the identification code, location, and date of installation of each geomembrane field panel.

5.4.0 Precautions during Panel Placement

CLC shall ensure that:

Any equipment used will not damage the geomembrane by handling, trafficking, excessive heat, leakage of fluids, or other means.

The prepared surface underlying the geomembrane has not deteriorated since previous acceptance and is still acceptable immediately prior to liner placement.

Any geosynthetic elements immediately underlying the geomembrane are clean and free of debris.

All personnel working on the geomembrane do not smoke, wear damaging shoes, or engage in other activities which could damage the geomembrane.

Methods used to unroll the panels does not cause scratches or crimps in the geomembrane and does not damage the supporting soil.

Methods used to place the panels minimize wrinkles (especially differential wrinkles between adjacent panels).

Adequate temporary ballast is placed over deployed lining panel edges to prevent wind uplift and is not likely to damage the geomembrane. In the event of high winds, continuous loading such as sandbags shall be placed end to end along edges of panels to minimize risk of wind effects.

Direct contact with the geomembrane is minimized. Geotextiles, extra liner or other suitable materials shall be used as protective buffers in areas where excessive traffic may be expected.

5.5.0 Damaged Material

CLC shall inspect the geomembrane after placement and prior to seaming for damage. Any damaged membrane that cannot be reasonably repaired shall be removed and replaced. Repairs to geomembrane shall be made according to procedures described in section 8.2.0.

PART VI SEAMING

6.1.0 Required Weather Conditions for Seaming

No seaming shall be conducted during periods of excessive moisture, blowing dust, or in the presence of excessive winds (unless wind barriers are provided). Seaming shall not take place in areas of ponded water.

High temperature limits for welding are dependent upon crew safety and membrane material limits. Elevated temperatures can create conditions whereby seam strength may be compromised and an inferior installation may result. When elevated temperature conditions exist over 95° F/35° C, weld quality shall be closely monitored during seaming operations.

No seaming shall be conducted during rain or snow, unless the seam is covered with an enclosure permitting favorable seaming conditions.

No seaming shall be attempted at ambient temperatures below 5° F without proper pre-heating of material promoting favorable seaming conditions.

In all cases, geomembrane shall be dry and protected from wind.

CLC shall verify that favorable weather conditions exist and advise the Owner's Representative if they are not.

6.2.0 Seaming and Related Equipment

Unless otherwise specified, all field seaming procedures shall be limited to two methods: extrusion welding and fusion (via hot wedge/"wedge welding"). The bulk of all panel to panel seaming shall be performed using the wedge weld technique. Extrusion welding shall be limited to areas where wedge welders cannot practically be deployed such as patching and pipe penetration sealing. These machines typically require gas or diesel fueled generators as power sources.

Each extrusion welding apparatus shall be equipped with gauges giving the temperature of the apparatus at the nozzle and extruder barrel.

Each wedge welding apparatus shall be equipped with gauges giving the applicable temperatures.

Although welding over a frozen, wet or muddy subgrade is generally not encouraged, fusion welding may be possible under such conditions by deployment of a movable slip-sheet of plastic placed directly below the overlapped membranes being seamed. Properly designed and deployed slip-sheets serve to prevent moisture buildup between the sheets being welded while providing conditions whereby wedge welding machines may be propelled at an uninterrupted rate of speed.

6.2.1 Equipment Preparation

Generator(s) shall be fueled outside the extents of the lining system and be inspected for fluid leakage and mechanical damage that may result in damage to the lining system. Should it be necessary to place the generator over the lining system a suitable buffer strip shall be placed between the tires and the membrane. Generators without inflated rubber tires shall not be introduced over the lining system. Tires shall be pre-inspected to be free of

foreign matter that may damage the membrane. Generators shall be positioned within close proximity of the seaming region and have adequate extension cords to complete an entire seam without the necessity to move the machine.

Wedge welders shall be calibrated for ambient conditions and the material type/thickness to be welded. The front part of the seaming device should be inspected for sharp corners and irregular details, which may damage the liner. The major point for inspection is that no sharp edges should exist where FML sheet surfaces must pass over the heated wedge element. If a dual, or split, hot wedge seam is being made, the recessed space for the air track should be examined. Knurled pressure rollers shall be inspected for sharp surfaces. All wedge welder adjustments shall be checked daily. Cleaning of machine should be done at least daily.

Extrusion welders shall have an initial inspection before warm up to confirm that the insulation and covers are in good condition and that the welding nozzles (or Teflon shoes) are correct for the FML to be seamed. Teflon shoes should be checked for proper weld bead geometry and excessive wear and replaced if necessary. They shall then be heated to the correct welding temperature for thickness of the material to be welded and then purged of all heat-degraded resin from within the barrel. During the purge process temperature controllers shall be monitored for proper function and that the welding rod feed systems and rotating tips are operating properly.

6.2.2 Trial Seams

Before any welding is performed by either method on the actual membrane lining system, trial seam welds must first be performed yielding passing results.

CLC shall prepare trial seams made with test strips of the actual membrane being installed to verify that seaming conditions are adequate. Such trial seams shall be made at the beginning of each seaming period (start of the day and midday) for each seaming apparatus used. Trial seams shall be made under the same conditions as actual seams.

The trial seam sample shall be approximately 3 feet/1.0 m long by 1 foot/0.3 m wide (after seaming) with the seam centered lengthwise. Seam overlap shall be nominally 4 inches/10.2 cm, 3 inches/7.6 cm minimum.

Unless otherwise specified, five (5) seam sample coupons each measuring 1"/25mm wide x 6"/150mm long shall be cut from the trial seam sample in increments to span its length. The specimens shall be tested in peel (3 ea.) and shear (2 ea.) modes using a field tensiometer. No seaming apparatus shall be used for seaming until deficiencies are corrected and two consecutive trial welds are successfully achieved.

6.3.0 Seam Layout

In general, seams should be oriented parallel to the line of maximum slope, in the direction of slope, not across the slope (horizontal to slopes). Horizontal to slope seams should be no less than 5 feet (1.5 m) from the toe of the slope or areas of potential stress concentrations unless otherwise approved by The Owner's Representative. When full roll lengths do not extend past the toe of the slope, panel ends may be seamed provided the panel end is cut at an angle greater than 45° to minimize seam stress. In corners and areas of irregular geometry, the number of seams should be minimized.

A seam numbering system compatible with a panel numbering system shall be employed.

6.4.0 Panel Overlap for Seaming

Controlled overlapping of adjacent sheets shall produce approximately 3 inches of overlap for extrusion welds and 4 to 6 inches of overlap between sheets for wedge welded seams. It is extremely important for the welder to understand and pay attention to the overlap, no pushing of wrinkles due to extreme overlap or twisting of the

machine should occur. In areas of questionable overlap the seam should be marked and extra inspections using approved test methods shall occur during the seam testing.

6.5.0 Seam Preparation

CLC shall verify that:

Prior to seaming, the seam area is clean and free of moisture, dust, dirt, debris of any kind, and foreign material, and seams are aligned with the fewest possible number of wrinkles or "fishmouths".

6.6.0 Wedge Welder Seaming Procedure

A smooth insulating plate or fabric shall be placed beneath the hot welding apparatus both before and after usage.

Unless otherwise specified, the general seaming procedure used by CLC shall be as follows:

The rolls of geomembrane shall be overlapped by approximately four inches (100 mm) for fusion welding and three inches for extrusion welding.

Welding can occur once the panels to be joined have been brought into their exact plan position for final installation.

"Fishmouths" or wrinkles at the seam overlaps shall be cut along the ridge of the wrinkle in order to achieve a flat overlap. The cut "fishmouths" or wrinkles shall be seamed and any portion where the overlap is inadequate shall then be patched with an oval or round patch of the same geomembrane extending a minimum of 6 inches beyond the cut in all directions.

When starting a new weld, the machine shall be manually placed into the overlapped sheet of material. The sheets shall then be guided between the idlers and the wedge element, and into the drive/nip rollers.

When starting a weld in the middle of two sheets, the material must be loaded from the sides. The machine is to be picked up a few inches, loading the bottom sheet first and top sheet second.

As soon as the wedge is in position and the nip rollers are engaged, the drive motor should be energized and the hot wedge moved into position and locked.

Welder alignment and temperature shall be monitored during the seaming process and any adjustments be made as necessary.

Should the machine tend to bulldoze the subgrade due to soil conditions, the operator shall take some of the weight off the front of the machine by lifting it slightly. Alternatively, a base for the machine to travel on could be provided consisting of strips of geotextile or geomembrane.

To avoid damaging membrane material, once the end of a seam is reached the drive and/or pressure rollers shall be immediately disengaged before the material runs completely out of the machine. The machine shall be withdrawn as quickly as possible to avoid damaging the membrane.

Seaming shall span the full panel length extend well into the anchor trench.

All cross seams or "T" intersections are to be extrusion welded where they intersect. The top flap of geomembrane shall be removed in the area to be extrusion welded.

6.7.0 Extrusion Welder Seaming Procedure

A smooth insulating plate or fabric shall be placed beneath the hot welding apparatus both before and after usage.

Using hot air welders or hand held heat guns with seam rollers the overlapping materials to be welded must first be pre-bonded to hold the materials in place before actual extruding.

Welding operations should be observed to assure that the machines are properly aligned resulting in weld beads that are centered over the edges of the top FML sheets and that weld bead appearances are smooth and uniform.

PART VII Non-Destructive Seam Continuity Testing

CLC shall non-destructively test all field seams over their full length using a vacuum test unit, air pressure testing, or other approved method. The purpose of non-destructive tests is to check the continuity of seams. It does not provide information on seam strength. Continuity testing shall be carried out as the seaming work progresses, not at the completion of all field seaming.

7.1.0 Vacuum Box Testing

This test method is almost exclusively used for evaluating extrusion weld bead quality. In areas where vacuum boxes cannot practically be deployed, the welds shall be visually inspected and manually probed over their full length to check adhesion.

The equipment shall be comprised of the following:

A vacuum box assembly constructed from clear transparent plastic with a soft neoprene gasket attached to the bottom and a gauge to indicate vacuum chamber pressure.

A vacuum motor capable of creating a vacuum of 2.5 to 3 psi.

A bucket and wide brush, mop or spray assembly.

A soapy solution.

Procedure:

Wet a strip of geomembrane approximately 12 inches by 48 inches (0.3 m by 1.2 m) with the soapy solution;

Place the box over the wetted area.

Energize the vacuum apparatus; confirm 2.5 to 3psi.

Ensure that a leak tight seal is created.

For a period of approximately 5 to 10 seconds, examine the geomembrane through the viewing window for the presence of soap bubbles.

All areas where soap bubbles appear shall be marked and repaired in accordance with Section 3.4.

If no bubbles appear, the vacuum shall be disengaged and the box indexed to the next test area with a minimum 6" overlap between indexes, and the process repeated.

Vacuum tested seams are recorded on Air Test Form.

7.2.0 Air Channel Pressure Testing

This method is only applicable to seam continuity testing of air channels produced using dual track hot wedge welding equipment.

Testing equipment shall be comprised of the following:

An air pump (manual or motor driven) equipped with pressure gauge capable of generating and sustaining a pressure between 24 and 30 psi (160 and 200 kPa).

An air hose with fittings and connections.

A sharp hollow needle or other approved pressure feed device.

Procedure:

Seal both ends of the seam to be tested by tack welding and clamping with Vise Grips;

Insert needle into the air test channel created by the fusion weld.

Inflate the channel as applicable to pressure between 24 and 30 psi (160 and 200 kPa), close pressurized air source valve and monitor air pressure drop for five (5) minutes.

Remove needle or other approved pressure feed device and seal.

If pressure drop exceeds values tabulated herein or does not stabilize, locate faulty area and repair and re-test until defects are corrected and test values are passing.

Pressure tested seams are recorded on Air Test Form.

**TABLE 6.2
SEAM PRESSURE TEST ALLOWANCE**

| Material Thickness | Minimum psi Test Pressure | Maximum psi Test Pressure | Maximum psi Drop Allowed After 5 Minutes |
|---------------------------|----------------------------------|----------------------------------|---|
| 30 mil | 24 | 30 | 3 PSI |

7.2.1 Pressure Test Failure

Should excessive pressure drop occur, both ends of seam shall be checked to insure proper seal and be re-tested. Should failure reoccur, the top fusion seam shall be checked by applying a constant air pressure to the air channel and applying a soapy water solution over the weld length. Any failure or leak will be indicated by continuous bubbles appearing.

If no failure appears in the top fusion seam area the seam shall then be systematically isolated into in one hundred and fifty linear foot sections of seam which shall each be re-tested by pressure testing until the leak is located. Failed seam areas shall be repaired by extrusion welding the outside edge of the top fusion weld between areas of failure. The extruded edge shall be vacuum tested in accordance with this manual.

7.3.0 Mechanical Point Stressing

This test method shall be used as a qualitative measure of the edge bonding. A blunt instrument shall be run along the seam to find obvious un-bonded areas. The procedure shall not puncture or otherwise damage the sheet material. Perform point stressing only after the seam has had sufficient time to cool. ASTM D4437.

PART VIII Destructive Seam Testing

Destructive seam tests (if required by the project specification) shall be performed at random selected locations at a frequency of one sample per every 1000 lineal feet of seam or as otherwise specified. Seam testing shall be conducted concurrent to the seaming work progress. Destructive seam samples shall be cut from overlapped areas or outside the boundaries of the containment such as anchor trenches to minimize damage and repairs to the liner.

Procedure

Samples shall be cut by CLC as the seaming progresses. CLC shall:

Cut samples.

Assign a number to each sample, which is to be based upon seam and sample number and mark it accordingly.

Record sample location on As-Built Drawing and Destructive Test Log..

All holes in the geomembrane resulting from destructive seam sampling shall be immediately repaired in accordance with repair procedures described in Section 9.2.0.

8.1.0 Sample and Coupon Size and Extraction

Unless otherwise specified, the following sample preparation guidelines shall govern:

Trial, representative or destructive seam samples cut from the installed liner shall measure 12"/30cm in width x 3'/1m in length with the width of the seam centered in the long axis of the sample. Coupons shall measure 1"/25mm wide by 6"/150mm long with the seam centered perpendicular to the length.

Coupon extractions shall occur in three paired locations along the length of the seam sample:

2 coupons at the beginning, 2 coupons in the center and 2 coupons at the end of the sample for a total of six (6) extractions. Coupons may be extracted and evaluated incrementally.

Sample Distribution

Remnant 12"/30 cm square samples shall be cut into parts, labeled as specified and distributed as applicable:

One portion for independent geosynthetic laboratory testing if previously specified

and

One portion to the Owner for archive storage

8.2.0 Coupon Field Testing

Coupons shall be tested with a tensiometer and evaluated for bonded seam strength (shear) and peel using methods ASTM D4437. Tensiometer jaw separation rate for bonded seam strength/shear and peel test shall be 2"/minute (5cm/min.)

All shear strength samples shall yield Film Tearing Bond (FTB) as defined in NSF 54 Annex A,

If the initial sample coupon test passes shear analysis yielding a FTB, the sample qualifies for further testing to obtain quantitative results until three (3) each peel samples and three (3) each shear samples are evaluated from the beginning middle and end of each sample.

If more than one (1) of six coupons per sample fails, the seam should be repaired in accordance with Section 7.3.0.

TABLE 7.2
REQUIRED FUSION AND EXTRUSION SEAM TEST RESULTS
Per NSF 54 1993 Standards

| Minimum Values Required (In Units of Pounds per inch of Width) | | | | |
|---|-----------------------|--------------------|------------------------|---------------------|
| Material Thickness | Peel Extrusion | Peel Fusion | Shear Extrusion | Shear Fusion |
| 30 mil LLDPE - Antiskid | 45 | 45 | 60 | 60 |

8.3.0 Procedures for Test Failure

Should a sample fails a destructive test, the defect may be remedied by:

Capping the respective seam in its entirety as described in this section,

Or

If a defect is suspected to be local to a certain area it may be further investigated to isolate the defective area by:

Taking small coupon test samples located 10' on either side of the defective sample seam void area. If these additional samples pass tensiometer testing, then full samples are to be taken. If these samples pass the tests, then the seam is capped between these locations. If either sample fails, then the process is repeated to establish the zone in which the seam should be reconstructed. All acceptable seam areas must be bounded by two locations from which samples passing destructive tests have been taken.

Cap stripping of defective seams or isolated areas shall be performed using either wedge or extrusion welding techniques or combination thereof and re-testing the repaired area with applicable methods as described herein. Cap strips shall cover the defective seam by no less than 6"/15cm On either side of the original weld. Wider patches will be required to cover seam sample void areas. In some cases at supervisor's discretion salvage edge can be tacked down and extruded then vacuum box tested.

CLC shall document all actions taken in conjunction with destructive test failures; e.g., capping of failed seam area.

PART IX Defects and Repairs

9.1.0 Identification

All seams and non-seam areas of the geomembrane shall be examined by CLC for identification of defects, holes, blisters, un-dispersed raw materials and any sign of contamination by foreign matter.

Defective/damaged materials shall be identified via a deficiency report, either separately or on the Daily Report. Actions taken to resolve or correct the problem will also be recorded on the similar form.

Defects, holes, blisters, un-dispersed raw materials, signs of contamination by foreign matter, unacceptable welds in geomembranes and other unsatisfactory conditions will be identified on the Daily Report form. The repair/corrective action to "fix" the problem will also be recorded on a similar form.

9.2.0 Repair Procedures

Available methods include:

Patching - used to repair large holes, tears, and contamination by foreign matter.

Spot welding or seaming - used to repair pinholes or other minor localized flaws;

Capping - used to repair large lengths of failed seams;

Methods for patching lining system defects shall consist of welding patches or caps over such areas using the same membrane lining material as used on the specific project. Patches or caps shall extend at least 6 inches beyond the edge of the defect, and all corners of patches shall be rounded with a radius of at least 3 inches.

Seaming, preparation and welding equipment deployment procedures previously addressed in this manual shall be adhered to during patching operations.

9.2.1 Verification of Repairs

Each repair shall be non-destructively tested using the methods described in Section 6 as appropriate. Repairs which pass the non-destructive test, shall be taken as an indication of an adequate repair. Failed tests indicate that the repair shall be redone and re-tested until a passing test result is obtained.

Part X Ancillary Items and Final Acceptance

10.1.0 Pipe Penetrations

Pipes penetrating through the lined area shall be sealed using pipe boot details that are welded to the lining system via extrusion weld method and sealed the pipe with double stainless steel banding clamps and butyl sealant tape. Pipe boots shall be fabricated from the membrane material being installed and shall fit snugly over the pipe and pipe to grade interface without undue slack or bridging. In instances where piping is manufactured from LLDPE, the pipe boot sleeve may be extrusion welded directly to the pipe foregoing the need for banding clamps.

10.2.0 Backfilling of Anchor Trenches

Anchor trenches, if any, shall be adequately drained by others to prevent ponding or otherwise softening the adjacent soils while the trench is open. The anchor trench shall be back-filled by others or as outlined in the specifications and bid documents.

Since back-filling the anchor trench can affect material bridging at toe of slope, consideration should be given to backfill the liner at its most contracted state; preferably during the cool of the morning or extended period of overcast skies. Care shall be taken when back-filling the trenches to prevent any damage to the lining system.

10.3.0 Lining System Acceptance

Once the lining system is installed and all quality assurance testing has been completed with satisfactory results, and the system is approved by Owner's Representative, the Representative shall sign an acceptance form provided by CLC prior to demobilization.

Insert Factory Spec sheet



Promoting Industry Growth • Providing Better Quality Workmanship

Approved Installation Contractor

This Certificate Recognizes That

Colorado Lining International, Inc.

Has achieved Approved Installation Contractor status through
the International Association of Geosynthetic Installers.

Valid through August 26, 2011



A blue ink signature of Carl Apicella.

Carl Apicella

A blue ink signature of Laurie Honnigford.

Laurie Honnigford
Managing Director, IAGI