

# HYPALON Geomembrane

## QA/QC Manual

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# SECTION I GENERAL INFORMATION

## TERMINOLOGY

The following definitions will be used throughout this document.

**HYPALON Geomembrane Manufacturer** –The party responsible for compounding the HYPALON and production of the HYPALON sheet or geomembrane.

**HYPALON Geomembrane Fabricator** –The party who receives the HYPALON sheet from the HYPALON Manufacturer and who is responsible for welding the sheets, through factory fabrication using controlled welding methods, into HYPALON geomembrane panels. **Colorado Lining International – 800-524-8672**

**HYPALON Geomembrane Installer** -The party responsible for placing and/or joining HYPALON geomembrane panels in the field or on the job site. **Colorado Lining International – 800-524-8672**

**HYPALON sheet** - The product of the HYPALON manufacturer, typically 1.548-m (5.08 feet) in width provided on rolls to the fabricator.

**HYPALON geomembrane or HYPALON panels or HYPALON geomembrane panels** – The term applied to multiple HYPALON sheets that have been welded together, through factory fabrication, under controlled conditions. The actual size of the panels will depend upon weight, mil thickness, and design configurations.

**Sample** -The piece of liner taken for testing or archival material. It is usually large enough to contain specimens for a series of tests.

**Seam** -The completed process of welding.

**Specimen** - The term applied to an individual part of a sample. Typically there are ten specimens taken from each sample. It is a specific piece of a sample upon which a test can be performed.

**Welding** –The process whereby two sheets of HYPALON are joined together.

## MANUFACTURING HYPALON SHEET

The geomembrane material shall be manufactured totally by calendaring, with each ply of rubber laminated to the next ply through the openings in the scrim weave to produce a pinhole-free construction. Exposed fabric or indication of delamination shall not be permitted.

## FACTORY FABRICATION OF SEAMS

The fabricator is responsible for welding the material together. The majority of the welding of the HYPALON geomembrane is done in the factory. The obvious advantage to factory fabrication is that the seaming is done under controlled conditions and the fabricator can control the environmental factors. Furthermore, mechanical factors are preset and easily monitored. Panels are custom fabricated to a specific width and length per project. **Colorado Lining International – 800-524-8672**

## FIELD INSTALLATION

The HYPALON is fabricated into large panels, which means the number of field welds is reduced significantly. On a typical project the field seaming is reduced by as much as 80% over non-flexible geomembranes. HYPALON liners generally can be installed much more quickly than a liner in which all of the welding must be done in the field. The size of the panel varies with the thickness of the material being used. The weight of the panel is the controlling factor in how large a panel can be. **Colorado Lining International 800-524-8672**

## SECTION II HYPALON QUALITY CONTROL SPECIFICATION

### 1.0 QUALIFICATION REQUIREMENTS: MANUFACTURER, FABRICATOR, AND INSTALLER

The HYPALON Manufacturer of the roll goods from which the liner is fabricated must have successfully produced a minimum of 2,000,000 square meters (20,000,000 square feet) that meets the HYPALON Geomembrane manufacturers specifications.

The HYPALON geomembrane Fabricator shall have assembled a minimum of 200,000 square Meters (2,000,000 square feet) for containment purposes. **Colorado Lining International 800-524-8672**

The HYPALON geomembrane Installer shall have installed a minimum of 100,000 square meters (1,000,000 square feet) of HYPALON geomembrane and be an IAGI member. **Colorado Lining International – 800-524-8672**

Evidence of experience shall include a list of completed facilities totaling at least the above number of square feet per category. The list should include the name and the purpose of the facility, location, geomembrane thickness, total square footage of the installation, date of installation, owner or project manager and engineer or designer. This list should include the contact name and telephone number of the appropriate person who can discuss this project.

### 2.0 QUALITY CONTROL REQUIREMENTS OF THE HYPALON GEOMEMBRANE MANUFACTURER

The HYPALON sheet material produced must be uniform in color, thickness, and surface texture. The sheet must be free of pinholes, blisters, and undistributed raw materials. HYPALON material must have uniform edges. The manufacturer must produce geomembranes to meet the manufacturer's specifications.

The HYPALON sheet material shall have minimum property values. The following are the tests conducted on the finished lining materials. Testing is done at standard temperature and humidity conditions. These tests are conducted after the material has been allowed to age for 24 to 48 hours. This allows the samples to obtain at least 95 percent of the full physical properties.

A sample from each lot of HYPALON geomembrane representing approximately 10,000 pounds is retained for testing. The samples are checked and the results must meet the manufacturer's specification for HYPALON Geomembrane.

### 3.0 FACTORY FABRICATION AND QUALITY CONTROL

#### 3.1 ROLL GOODS MATERIAL TESTING

The Manufacturer of the liner material shall provide certification to the Fabricator that the material meets minimum property values as detailed in the manufacturer's specifications. 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.

In addition, the edges of the HYPALON material must lay flat and have no exposed scrim. This is necessary in order to achieve a conforming weld.

#### 3.2 FABRICATION (IN-FACTORY WELDING)

HYPALON geomembranes sheets are typically transported in rolls. The rolls are welded together and tested for seam integrity by the Fabricator before going to the job site. The panel is then packaged and labeled according to Section 3.5 of this document. **Colorado Lining International – 800-524-8672**

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, bar, band, or hot air.

Chemically fused seams are used for patching or short runs only. Chemically fused seams are made by first overlapping the HYPALON liner material and then placing a controlled application of chemical fusion agent between the two sheets. Pressure is applied to adhere the sheets and any excess fusion agent that may seep from between the seams is wiped off of the liner. Then a roller or paddle is used to disperse the fusion agent and eliminate any air bubbles. The chemical fusion agent gradually dissipates after the seam is made. All exposed scrim ends must be flood-coated with adhesive to seal them during the application of the patch.

### **3.3 IN-FACTORY SEAM TESTING AND REQUIREMENTS**

The finished seams will be tested at a minimum once every 4 hours or once per fabricated panel, whichever is more frequent. The following quality control tests will be conducted on each sample.

<b>PROPERTY TEST</b>	<b>METHOD</b>	<b>VALUE</b>
Bonded Seam	ASTM D751	160 lbs/inch
Peel Adhesion Test	ASTM D413 Machine Method Type A	20 lbs/inch

If a sample fails, the Fabricator should immediately determine why the seam failed and take necessary corrective measures. A second sample is then taken. If it passes, then the panel passes provided any problems have been corrected. If it fails, then the seam is removed and a new seam constructed.

The results of testing must be documented and available to the owner and/or engineer responsible for the project. The fabricator shall provide, at the request of the engineer, copies of all Test Logs prepared for the Project.

The Fabricator, within a reasonable period of time, will provide to the Engineer, manufacturer material certifications and/or copies of the quality control test results for all panels to be used, verifying conformance with this specification HYPALON geomembranes. The location of any defects and repairs and all necessary retesting results will also be documented in the certification.

All testing equipment (both laboratory and field equipment) must be recalibrated on an annual basis by a qualified third party.

### **3.4 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 HYPALON 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.

### **3.5 PACKAGING, SHIPPING AND LABELING**

Fabricated HYPALON panels are accordion-folded in both directions and rolled on a 6" core. Rolled panels are wrapped with a shrink film plastic and are moved by use of the 6" core.

Custom or site specific packaging, while not frequently done, may be specified by the Engineer and/or Owner in advance.

The panel shall be packaged so as to prevent damage during shipping. The outside of the packaging shall be labeled in order to properly place the panel on the job site.

Each panel should also be labeled with panel size, and identification of panel for field placement. All markings should be done with permanent marking pens or permanent stamps.

### **3.6 DOCUMENTATION**

The Fabricator and Installer will provide experience statements as detailed in Section 2.0 above.

The Fabricator will provide the Manufacturer's Certification that the liner material meets the manufacturer's specifications. Additionally, the Fabricator, within the reasonable period of time, will provide copies for the Factory Seaming Test Logs that are appropriate to the panels being shipped to the job site.

Each panel should have a history of what tests were performed and what the test results were.

## **4.0 FIELD INSTALLATION PROCEDURES**

### **4.1 HANDLING AND STORAGE REQUIREMENTS**

The panels that are delivered to the job site are off loaded from the trailer by either forklift or cradle style using slings/chains and a handling bar.

If the panels are not to be deployed immediately, the Owner will be responsible for providing storage and on-site security. The geomembrane must be stored so it is protected from puncture, moisture, mechanical abrasions, or other conditions, which may cause damage.

The panels must remain in their original, unopened containers.

### **4.2 MEETINGS**

A Pre-Construction Meeting should be held prior to liner placement. The purpose of this meeting is to identify the responsibility and authority of the various parties involved. Additionally, any changes in the procedures that may be necessary should be discussed at this time. The meeting should be attended by Owner/Engineer Representatives, COA party, and the liner installer's Project Manager.

Progress Meetings should be held from time to time as is necessary to resolve problems and maintain the lines of communication.

### **4.3 SUBGRADE PREPARATION DETAILS**

The General Contractor or the Earthwork Contractor shall be responsible for preparing and maintaining the subgrade in a condition suitable for installation of liner. Special care must be taken to maintain the prepared soil surfaces. Any damage to the surface caused by weather conditions or other conditions must be repaired by the Earthwork Contractor. The installer will submit to the Owner/Representative, prior to installing the geomembrane material, written approval of the subgrade surface on which the liner will be installed.

#### **4.3.1 SURFACE CONDITION**

All surfaces in contact with the liner must be free of sharp stones, stones over 3/8 inches in diameter, sticks and other debris that can puncture or tear the liner. No standing water, mud, snow or excessive moisture should be on the subgrade when the liner is deployed.

Sub-grade should be constructed of a firm stable material compacted to a 95% proctor. Slopes should be between a 3 to 1 and 4 to 1 slope ratio. It is recommended that cover soils be tested by a lab for friction angle interface before use. If there is any deviation in this practice, the engineer must approve the deviation in writing.

#### **4.3.2 GROUND WATER ELEVATION**

If the liner will be installed at an elevation below the current or possible ground water elevation, the Owner is responsible for providing an adequate under drain system. It is the responsibility of the project designer to ensure the under drain is appropriate for the project.

#### **4.3.3 ANCHOR TRENCHES**

The anchor trench shall be excavated by the General Contractor or the Earthwork Contractor prior to geomembrane placement. Anchor trenches excavated in clay soils susceptible to desiccation cracks should be excavated only the distance required for that day's liner placement to minimize the potential desiccation cracking of the clay soils.

#### **4.3.4 GAS VENTING**

There is a possibility of the gas forming under the liner, a proper venting system must be designed. Speak with your CLI representative for suggested conceptual details on gas vents that may be used in a liner system. Specific projects may require different venting systems.

It is the responsibility of the Project Designer to ensure if a gas venting system is appropriate for the design.

#### **4.3.5 SOIL STERILIZATION**

Sterilize areas containing nut grass, quack grass or other potentially harmful plant life. It is the responsibility of the Project Designer to check with the manufacturer of the sterilent to ensure that the chemicals used are compatible with the liner material. Apply sterilent according to manufacturers' directions 48 hours prior to liner installation.

#### **4.3.6 SUBGRADE ACCEPTANCE**

Immediately prior to installation of the designated geomembrane, soil surface will be noted by the installer. No geomembrane material will be placed on a subgrade surface that has become visibly softened by water, or overly dried, until it has been properly reconditioned and/or recompacted.

#### **4.3.7 SUBGRADE MAINTENANCE**

Compaction specification will be determined by the Project Designer. The subgrade/soil surface will be maintained by the Earthwork Contractor.

#### **4.4 DEPLOYING THE LINER**

The HYPALON geomembrane will be deployed in such a manner as to minimize handling. The liner shall be placed in a relaxed condition and shall be free of tension or stress upon completion of installation. The liner is not to be stretched.

#### **4.4.1 TEMPERATURE CONDITIONS**

The liner is generally deployed when the ambient temperature is above 0°C (32°F) or below 50°C (122°F). If the material is deployed at temperatures outside this range, it can be done with the permission of the Engineer and/or Owner.

If the material will be installed at temperatures outside of this range, special installation considerations should be agreed upon in advance. A geosynthetic installer's cold weather-seaming plan should be written into the specifications if there is a concern that the job will be extended into cold weather.

HYPALON liners have been installed in temperatures lower than 0°C (32°F); however, special installation guidelines must be followed. These guidelines are beyond the scope of this manual. It is suggested that a cold weather installation plan be agreed upon in advance.

#### **4.4.2 LINER LOADING**

Temporary ballasts can be put into place to hold the liner if the wind is a concern. Sandbags or other equivalent means to prevent uplift (i.e. tires) may be used. However, care should be taken to be sure there are no sharp edges that may tear or puncture the liner.

Geomembrane panels which have been displaced by wind should be inspected and approved by the Engineer on site. If the geomembrane has been damaged by wind uplift, the damage should be repaired by patching those sections torn, ripped or punctured. Patching methods are described in section 4.8 below.

#### **4.4.3 LINER TRAFFIC**

Materials or equipment shall not be dragged across the surface of the liner. Any portion of the liner damaged during installation, by any cause, shall be repaired by using an additional piece of HYPALON lining. All parties walking or working on the liner shall wear shoes that will not damage the liner.

No vehicles, other than those approved by the installer, are allowed directly on the geomembrane. Small rubber tired equipment with a ground pressure not exceeding 35 kPa (5psi). Only equipment required during installation and for testing should be allowed on the liner.

#### **4.4.4 "RELAXED INSTALLATION"**

Minimum wrinkles will be allowed to insure the liner is installed in a "relaxed" condition. Excessive wrinkles which overlap themselves will not be allowed.

#### **4.4.5 DEPLOYMENT SCHEDULE**

Only those panels which can be seamed together in the same day should be deployed. The soil covering operation can begin as soon as the seams have been approved.

#### **4.5 ANCHORING SYSTEMS**

It is the responsibility of the Project Engineer to ensure that the anchoring systems are appropriate for the job. A typical anchor trench is 45 cm vertical by 30 cm horizontal (1.5 foot vertical by 1 foot horizontal). Some variations may be necessary due to design considerations and site specific needs.

#### **4.6 SEAMING AROUND PENETRATIONS**

The HYPALON membrane shall be sealed to all concrete structures and other openings through the lining in accordance with details shown on the engineer-approved shop drawings. Factory and/or fabricated pipe boots shall be used to seal all pipes penetrating the liner. All joints shall be tightly bonded.

## **4.7 FIELD WELDING METHODS**

All welding methods require that the seaming surfaces must be clean and dry. If the liner needs to be cleaned: clean, dry rags may be used. The welding operation requires a firm, smooth subsurface. Any conditions that make it difficult to weld must be adjusted prior to welding.

Trial welds are to be conducted by the technicians prior to each welding period. All trial welds will be conducted under the same conditions as will be encountered during the actual welding.

Weather conditions will affect the welding process. Welding is best performed when sheet temperature is between 10°C (50°F) and 40°C (105°F). If the temperature is higher than 40°C (105°F), welding may continue, however changes in the welding process may be necessary. If the temperature is lower than 10°C (50°F) extra care needs to be taken for cold weather installation. This may, although not always, involve building a shelter from the natural elements. Other methods, such as pre-heating the liner prior to welding, may be deemed necessary by the HYPALON installer.

Increased quality control measures may be necessary under cold weather circumstances. The weather conditions that the welding was performed in should be documented.

Care should be taken to avoid “fishmouths” in field seams. When “fishmouths” do occur, slit the liner out far enough from the seam to dissipate the “fishmouth”. Overlap the edges and then weld together and patch a large enough area so that the sheet lays flat once patched.

### **4.7.1 THERMAL WELD**

Thermal welds are made using a hot wedge welder. The minimum seam width for hot wedge welding is a nominal 2.5-cm (1-inch). The wedge is electrically heated and passes between two sheets of liner. As it melts, the surface pressure is applied and the seam is formed. These machines have automated control of temperature, speed of travel and the amount of pressure applied. The temperature and travel rate settings used to construct a seam should be documented.

Chemically fused seams are used for patching or short runs only. Chemically fused seams are made by first overlapping the HYPALON liner material and then placing a controlled application of chemical fusion agent between the two sheets. Pressure is applied to adhere the sheets and any excess fusion agent that may seep from between the seams is wiped off of the liner. Then a roller or paddle is used to disperse the fusion agent and eliminate any air bubbles. The chemical fusion agent gradually dissipates after the seam is made. All exposed scrim ends must be flood-coated with adhesive to seal them during the application of the patch.

## **4.8 PATCHES AND REPAIRS**

Place a patch of the same material with a minimum of 150-mm (6 inches) overlap over the damaged area. The patch should have rounded corners. Apply heat to damaged membrane; place the patch over the damaged area; and apply pressure to the two surfaces in order to achieve intimate contact between the liners. The bonded area of the patch perimeter should be a nominal 100-mm (4 inches).

Cap stripping is the method of bonding a separate strip of the parent material over the seamed edge. Cap stripping may be used to repair an extended length of seam. Caps shall extend a minimum of 150-mm (6 inches) beyond the limits of the nonconforming seam and all corners shall be rounded. The bonded area of the cap-strip perimeter

should be a nominal 100-mm (4 inches). A cap-stripped section must be nondestructively tested as outlined in Section 4.9. This method can be achieved by using a hand held heat gun and thermally welding the patch or cap-strip.

#### **4.9 NON-DESTRUCTIVE SEAM TESTING**

Non-destructive seam testing is meant to verify the continuity of field seams. Generally, non-destructive testing is done as the seaming progresses or as soon as the seam has cured. One hundred percent of the field seams are non-destructively tested in the field as are patches and appurtenances. Mark any areas in need of repair or patching with a permanent-marking pen.

Any seams found not to be bonded need to be repaired and re-tested. Patches and cap stripping must be non-destructively tested. All seams tested and found to be acceptable should be marked with a permanent marker to provide proof that the seam was tested.

Visual inspection must be done on all seams. However, it is not recommended that this be the only method used for testing seam integrity.

##### **4.9.1 AIR LANCE TEST (ASTM D4437)**

The most common type of non-destructive seam testing is the air lance test. In this test, air is forced through a nozzle 2.44-mm (3/32 inch) to 4.88 mm (3/16 inch) in diameter at 345 kPa (50 psi), held not more than 5 cm (2 inches) from the seam edge and directed at the seam edge. The air stream is run along the edge of seam. (Thermal wedge welds will not be bonded at the edge of the top sheet.)

This should be done along all field seams, appurtenances, patches, and cap stripping. Any loose areas will be detected by a high pitched sound at the point of the opening. The areas found to be loose should be marked for repair. When UN-bonded areas are located, they can sometimes be repaired by supplying heat into the opening and applying pressure. If that is not satisfactory, repairs should be made by patching or cap-stripping the area. The patch also needs to be tested to ensure integrity.

The testing of seams should be witnessed by a Representative of the Owner or the Owner's Construction Quality Assurance Representative. The installer will be allowed to continue air lance testing if the Owner's Representative or Construction Quality Assurance Representative declines to witness the testing.

#### **4.10 DESTRUCTIVE SEAM TESTING**

Cut a random sample to take five peels and five shear specimens from the installed geomembrane. Patch the hole using an oval piece of the liner material and seam according to Section 4.7. The frequency of sampling should be determined in advance.

Each destructive sample shall, at a minimum, measure 30 cm (12 inches) wide by 60 cm (24 inches) long. The seam should be centered in the sample. The number of samples can be increased if more samples are needed. One sample should be given to the installer and the second sample should be given to the owner. The owner may at their discretion and expense, promptly send this sample to a third party for immediate testing. The location of each sample taken must be noted on the record drawings.

An identifying number or letter is put on the sample with permanent marker. Mark all samples with their location, panel and seam number. Also record the date, time and name of technicians, ambient temperature and subgrade condition at the time the seam was made. Record the sample number on a Chain of Custody Form (See Section 4.11 below).

Prior to testing, allow the specimens to cure, if necessary, according to the ASTM test method. Thermal welded seams can be tested immediately.

Five specimens are taken from the sample. Four of the five specimens must pass for the sample to pass. The following procedure will apply whenever a sample fails a destructive test. The installer will either:

- A. Reconstruct the seam between any two passed test locations, or
- B. Trace the seam outward to intermediate points (at least 3.0 meters (10 feet) from the location the failed test in each direction) and take a small sample for additional field tests at each location.

If this sample passes the field test, a fill sample will be cut for verification, If the sample passes the test, the seam is then reconstructed between these two locations. If an intermediate sample fails, the process is repeated to establish the zone in which the seam should be reconstructed.

All reconstructed seams must be bounded by two locations from which samples passing other destructive tests have been taken. Over the length of the unacceptable seam (seam between two successful test locations that bracket a test failure), Colorado Lining International will either cut out the old seam reposition the panel and re-seam, or add a cap strip, extending 150 mm (6 inches) beyond the limits of the non-conforming seam.

#### **4.11 SAMPLE CUSTODY**

Whenever a sample is taken a Chain of Custody record should be made for that sample. If the sample is sent to a laboratory or another individual, this change in custody should be noted. A chain of custody record minimizes the possibility of losing a sample. Additionally, anomalous test results may be able to be traced and other testing problems recorded.

#### **4.12 DAILY LOG**

The installer will maintain a log of each day's work. Included in this log will be:

- Date
- Ambient Temperature
- Weather Conditions
- Panels Deployed
- Field Seams Constructed
- Seaming Technicians
- Inspections