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CQC MANUAL FOR HDPE OR LLDPE

Construction quality Control (CQC) is a planned system of routine inspections that is used to monitor and control the quality of a material or a construction project.

PARTIES

Owner- Owner of the property and/or facility.

Designer- Architectural and/or engineering entity responsible for projects planning, design, specifications and drawings.

Project Manager- Authorized representative of the owner

General Contractor- Prime Contractor for the project. The General Contractor is sometimes the Liner System Installer and/or the Earthwork Contractor.

Liner Installer- Subcontractor for the complete installation of the synthetic liner systems.

Liner Manufacturer Manufacturer of the geomembrane.

CQA Consultant/ Inspector Party, independent of the General Contractor and the Liner Installer in charge of monitoring, testing, inspecting and documenting.

Independent Laboratory- Testing Laboratory unaffiliated with the geosynthetic Material Manufacturer, Installer or the General Contractor.

1. PRE-CONSTRUCTION MEETINGS

A meeting should be held after the award of the contract and prior to starting the construction of the facility to resolve any uncertainties and review construction objectives. This meeting should conclude with a walk around the site, to review construction material and inspecting equipment storage locations.

1.1 DAILY PROGRESS MEETINGS

A weekly meeting shall be held at the work site. The meeting should include the Installer and the inspector and the General Contractor. The purpose of the meeting is to:

1. Review the project's activity
2. Agree on measurements of specific areas

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3. Discuss possible problem areas and situations

2. MATERIAL LOGISTICS

2.1 Transportation

Geomembrane rolls or panels are packaged and shipped in a manner that will protect them from damage.

2.2 Delivery

Off-loading and storage of the geomembrane is the responsibility of ALS or of the Contractor if delivery precedes the job site arrival of ALS personnel. Damage during off-loading shall be documented by the inspector and ALS.

2.2 On-Site Storage

Stored geomembrane shall be safely protected against puncture, dirt, grease, water, moisture, mud, excessive heat and other potentially damaging conditions. Geomembrane rolls shall be stored on a prepared surface (not wooden pallets) and shall not be stacked more than three high on soil sub grade.

3. EARTHWORK

The owner or general contractor shall supervise the sub grade preparation. All surfaces to be lined shall be smooth, free of all foreign and organic material, sharp objects or debris of any kind. These surfaces shall be compacted to provide a firm, unyielding foundation with no sharp changes or abrupt breaks in grade. Standing water or excessive moisture shall not be allowed. Stones or rocks exceeding ¼" and not of angular shape shall not be allowed in the top 6 inches of soil.

Vegetation Control

The general contractor, if necessary, shall sterilize the area using an effective soil sterilant specifically formulated for vegetation present in the area. The sterilant shall not be harmful to the liner and shall be applied according to its manufacturer's recommendation.

Anchor Trench

The anchor trench shall be excavated to the line, grade, width and depth shown on the construction drawings prior to liner system placement. Slightly rounded corners shall be provided in the trench where the geomembranes adjoins the trench so as to avoid sharp bends in the geomembrane.

4. LINER DEPLOYMENT

1. No equipment or tools shall damage the geomembrane by handling, trafficking or other means.

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2. No personnel working on the geomembrane shall smoke, wear damaging shoes or engage in other activities that could damage the geomembrane.

3. The method used to unroll the panels shall neither score, nor crimp the geomembrane, nor damage the supporting soil or underlying geotextile.

4. Adequate loading (sand bags) shall be placed to prevent uplift by wind.

Basic Seaming Strategies

Seams shall be oriented parallel to the liner of maximum slope, i.e., oriented down, not across the slope. No base T-seam shall be closer than 5 feet from the toe of the slope. All field seams shall be logged.

Seam Overlap

Panels of geomembrane must have enough finished overlap to allow for peel tests to be performed on the seam.

Field Seam Testing

Field tests shall be conducted on geomembrane liner seams to verify that seaming conditions are satisfactory. Test seams shall be conducted at the beginning of each seaming period and at least once every four hours for each seaming apparatus used that day. The start-up seam samples shall be 10 feet long for hot wedge welding and 3 feet long for extrusion welding with the seam centered lengthwise. One-inch wide specimens shall be cut from the test seam. A tensiometer shall be used to test these specimens for shear and peel. If a test seam fails to meet field seam specifications, the seaming apparatus and/or seamer shall not be used for seaming until the deficiencies are corrected and successful test seams are achieved.

5. WEATHER CONDITIONS

Liner deployment will proceed between ambient temperatures of 40 degrees F. to 122 degrees F. Placement can proceed only after the inspector verifies that the material can be seamed in accordance with the specifications. Geomembrane will not be placed in the midst of precipitation or moisture of any type (e.g., fog, rain or dew), or in the presence of excessive winds. Observance of temperature, humidity, precipitation and wind should be noted to ensure the weather conditions are acceptable prior to membrane placement.

6. HOT WEDGE WELDING

The “hot wedge” welding machine is a self-contained system that produces a bonded seam by running a hot metal wedge between the overlapped area of the HDPE membranes. The hot wedge melts the facing surfaces of the two contiguous liners and creates a permanent bond between them using precisely controlled heat. The heated geomembrane overlaps come together at the tapered end of the hot wedge, under pressure from two nip/drive rollers, and are

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permanently fused together. Neither hot air tacking nor grinding drive rollers (as employed in extrusion fillet seaming) is necessary. A dual hot wedge has central canal-like recession along its length. This type of wedge creates a channel in the liner seam between two parallel bonds. Knurled rollers are used to apply pressure to the sheets where they have just passed over the taper of the hot wedge and been bonded

6.1 Liner Preparation for Hot Wedge Welding

Hot wedge welding is the primary seaming method for HDPE

1. The two liners to be joined must be overlapped 4 to 6 inches.

2. Sheets must be clean and dry.

3. Seaming should not be performed during rain or snow unless measures are taken to allow the seam to be made on dry liner materials, e.g., within an enclosure or shelter.

4. Seaming should not be performed when the soil surface beneath the liners is saturated.

6.1 Hot Wedge Seaming Process

1. The operator must constantly monitor the temperature controls, as well as the completed seam passing out of the machine. Occasional adjustments in temperature or speed will be necessary to maintain a consistent weld. Visual inspection and constant hand testing by the peel method is recommended.

2. On some soils, the device tends to "bulldoze" into the ground as it travels, causing soil to enter the weld. A seam with soil trapped in its weld is unacceptable. To keep this from happening, the operator should lift the front of the machine slightly if "bulldozing" occurs or seems likely. Alternatively, a moveable base for the machine to travel can be used. A geomembrane "runner" has proven to be an effective material upon which the welder can continue to move.

6.2 After Hot Wedge Seaming

A small amount of extrudate is an indication that proper seaming temperatures have been achieved. The melted polymer will laterally extrude out of the seam zone in properly welded seams.

1. For HDPE liners of 40 mil thickness and less, a long, low wavelength pattern in the direction of the seam indicates a proper weld. If the wave peaks are too close together, machine speed should be increased until a satisfactory pattern shows. The absence of this wavelength pattern indicates that machine speed should be decreased.

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2. Nip/drive roller marks will always show on the surface when using knurled rollers. They should be noticeable to the eye, but just barely to the touch.

3. The hot wedge device has just a few adjustable parts, but it is critical that they be checked and cleaned after every day of seaming.

7. EXTRUSION FILLET WELDING

An extrusion weld is produced by using a 4 or 5 mm diameter welding rod that is manufactured from the same resin as the membrane. The welding rod is applied as a "bead" or extrudate at the edge of two overlapped membrane sheets, resulting in a welded seam.

7.1 Liner Preparation of Extrusion Fillet Seaming

Extrusion fillet seaming represents the second method of seaming HDPE sheet. Around detail such as pipes and sumps it is always necessary to use extrusion fillet seaming.

1. The two liners to be joined must be positioned to create an overlap of at least 3 inches to allow for testing procedures.

2. The seam area must be completely free of moisture before the overlapping sheets can be properly seamed.

3. Puddles of water under the liner are unacceptable.

4. Seaming should only be conducted when ambient temperatures are between 40 – 122 degrees F. unless it can be proven via test strips that good seams can be fabricated at such temperatures.

5. When seaming in cold weather, it is advisable to preheat the sheets with a hot air blower.

7.2 Extrusion Fillet Seaming Process

1. For liners 60 mil and thicker, the upper sheet's leading edge must be ground to a 45 degree.

2. After beveling, the seam area is prepared by grinding. All grind particles must be wiped or blown away from the seaming area. Grinding width shall not exceed the approximate extrudate or "bead" width.

3. Seaming must happen soon after the grinding process is completed.

4. A hot air device is used to "spot tack" or secure the sheets before the hot air machine prepares the seam for extruding.

5. The extrusion welder shall be purged of all heat-degraded extrudate before starting a seam. This must be done every time the extruder is restarted after two or more minutes of inactivity.

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6. The bead should be approximately twice the specified sheet thickness, measured from the top of the bottom sheet to the top or "crown" of the bead. Excessive squeeze-out (or "flashing") is acceptable.

7. If the seaming process must be interrupted at mid seam, the extrudate should trail off gradually, not terminate in a large mass of solid extrudate. Where such welds are abandoned long enough to cool, they must be ground prior to continuing with new extrudate over the remainder of the seam. Grind where the extrudate trail-off begins.

8. SEAM PROPERTIES AND FIELD TEST PROCEDURES

8.1 Seam Properties

Field seams shall meet the following specification:

Seam Property	Test Method	Requirements
Shear Strength	ASTM D 6392 (as modified in Annex. A of NSF 54)	>95% of the liner minimum yield strength Field Tear Bond
Peel Strength	ASTM D 6392 (as modified in Annex. A of NSF 54	>72% of the liner minimum yield strength Field Tear Bond 60% for Extrusion

1. Seam specimens are one inch wide, grip separation rate is two inches per minute (IPM).

2. Both shear seam strength and peel tests shall be run on five specimens. A break through the weld or at the weld/sheet interface shall be considered a Non-FTB (failure) in both seam strength (shear) and peel strength test. Four of the five specimens shall pass. Film Tear Bond is a condition where one of the welded sheets fails by tearing, but the weld between the two sheets remains intact.

8.2 Non-Destructive Seam Testing

8.2.1 Air Pressure Testing (For Double Fusion Seam Only)

The following procedures are for double seam ("split wedge") seams.
Equipment for testing double fusion seams shall be comprised of the followin

1. An air pump equipped with pressure gauge capable of generating and sustaining readings between 25-30 psi.

2. A manometer equipped with a sharp hollow needle, or other approved pressure feed device. The following procedures shall be followed.

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3. Seal both ends of the seam to be tested.

4. Insert needle or other approved pressure feed device into the tunnel created by the double wedge fusion weld.

5. Energize the air pump to between 25-30 psi, close the valve, and sustain this pressure for approximately five minutes.

6. If more than 2 psi is lost, or pressure never stabilizes, locate the faulty area, then repair and retest.

7. After pressure is maintained for the specified period of time the trail end of air channel should be slit to remove air. This ensures that the entire length of the channel was pressurized.

8. If faulty area cannot be located, the vacuum testing method may be employed to prove the leak-proofness of that seam.

8.2.2 Vacuum Box Testing

The complete apparatus for testing single wedge fusion seams and extrusion seams shall be comprised of the following components:

1. A vacuum box assembly consisting of a rigid housing, a transparent viewing window, a soft rubber gasket attached to the bottom, port hole or valve assembly, and a vacuum gauge.

2. A steel vacuum tank and pump assembly equipped with pressure controller and pipe connections.

3. A rubber pressure/vacuum hose with fittings and connections.

4. A plastic bucket

5. A soapy solution

The following procedure shall be followed:

1. Excess sheet overlap shall be trimmed away.

2. Energize the vacuum pump and reduce the tank pressure to approximately 3-4 psi.

3. Apply soapy solution to the seam.

4. Place the box over the wetted area and compress.

5. Close the bleed valve and open the vacuum valve.

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6. For a period of approximately 15 seconds, examine the geomembrane through the viewing window for the presence of bubbles. If no bubbles appear after 15 seconds, close the vacuum valve and open the bleed valve, move the box over the next adjoining area with a minimum three inches overlap and repeat the process.

7. All areas where soap bubbles appear shall be marked repaired and then retested.

8. If the seam cannot be vacuum-tested prior to final acceptance, the seaming operation shall be observed by the inspector for uniformity and completeness.

8.3 Destructive Seam Testing

ALS shall provide one destructive test sample per 500 LF of seam from a location specified by CQA Inspector.

Sampling Procedure

Samples shall be cut as the seaming progresses. The CQA Inspector shall determine sampling times and locations. The CQA Inspector must witness the collection of all field test samples and the Installer shall mark all samples with their location, roll and seam number. ALS shall also record in writing the date, time, location, roll, seam number, ambient temperature and pass or fail status. A copy of this information must be attached to each sample portion. All holes in the geomembrane created by collecting seam samples shall be immediately repaired and vacuum tested.

Size and Disposition of Samples

The samples shall be 12 inches wide by 42 inches long with the seam centered lengthwise. The samples shall be cut into three pieces of equal length. One section shall be given to each party. (Geosyntec Consultants CQA Lab, the Owner's Representative and ALS)

Field Tensile Testing

ALS shall cut the seam sample in to ten one-inch wide specimens and tested by ALS. The grip-separation rate of two i.p.m. will be used. Five shall be tested for shear strength and five for peel strength. Four of each five specimens must pass the test.

Independent Laboratory Testing – 3rd Part Testing

When third-party laboratory testing is specified by the designer, the General Contractor will pack and ship the samples to a laboratory. Sample results should be expedited so as not to delay liner installation. All costs borne by General Contractor.

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Procedures for Destructive Test Failure

The following procedures shall apply whenever a sample fails the field or third party laboratory destructive test:

1. ALS shall reconstruct the seam between the failed location and any passed location.

2. ALS can retrace the welding path to an intermediate location (at least 10 feet from the failed location) at the CQA Inspector's discretion and take a small sample for an additional field test. If this sample passes, the seam shall be reconstructed between that location and the original failed location. If the sample fails, the process is repeated from a farther intermediate location.

3. Over the length of a seam failure, ALS shall cut out the old seam, reposition the panel and re-seam, add a cap strip or any other approved method.

4. At the CQA Inspector's request, additional destructive field test (s) shall be taken within the re-seamed area after re-seaming or placement of the cap strip. The re-seamed sample shall be found acceptable if the CQA inspector approves test results. If test results are not acceptable, this process shall be repeated until the reseamed length is judged satisfactory by the CQA inspector. In the event that a sample fails a laboratory destructive test, the above procedures shall be followed.

8.4 Defects and Repairs

All seams and non-seam areas of the geomembrane shall be examined by the CQA inspector for defects, holes, blisters, undispersed raw materials and contamination by foreign matter. Because geomembrane is uniformly smooth, defects are easily detectable in normal daylight. Consequently, the surface of the geomembrane shall be clean during critical inspection.

8.4.1 Repair Procedures

1. Small holes shall be repaired by extrusion cap welding. If the hole is larger than ¼ inch, it shall be patched with a piece of material extending six inches out from the seam.

2. Tears shall be repaired by patching. The sharp end of a tear on a slope, or in an area of particular stress, must be rounded prior to patching.

3. Blisters, large holes, undispersed raw materials and contamination by foreign matter shall be repaired by patches.

4. HDPE surfaces to be patched shall be abraded and cleaned no more than 15 minutes prior to the repair. No more than 10% of the thickness shall be removed.

5. Patches shall be round or oval in shape, made of the same geomembrane and extend a minimum of six inches beyond the edge of defects. All patches shall be of the same compound thickness as the geomembrane specified. Patches shall be applied using the extrusion welding method.

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8.4.2 Cover Soil Placement

If cover soil is required, it should be placed over the liner system when the lined area of the facility has been complete and accepted by the Owner, and laboratory tests have all been verified as passing. Extreme care shall be taken by the Earthwork Contractor not to damage the liner system during the cover soil placement. Cover soil shall be placed on side slopes from the bottom to the top of the slope. During the cover soil placement, the driver shall not make sharp turns or sudden starts and stops. The machinery speed shall be slow, usually not to exceed five-mph.

8.4.3 Anchor and Pipe Penetrations

When a landfill or impoundment unit calls for penetrations in the flexible membrane liner, CQA personnel must insure that the seals around the penetrations have integrity and are compatible with the particular waste that will be impounded. Penetrations and seals should be isolated from the seasonal effects of liner expansion and contraction. Such penetrations should allow for reasonable access for extrusion welding equipment.

9. BACK-FILLING OF ANCHOR TRENCH

General Contractor shall perform the backfill and compaction of the trench. Trench backfill material shall be placed and compacted by the general contractor per 02200-6-3.08
Care shall be taken when backfilling the trenches to prevent any damage to the geomembrane, geotextile or GCL. At no time shall construction equipment make direct contact with the geosynthetics.

10. GEOMEMBRANE ACCEPTANCE

ALS shall retain all ownership and responsibility for the geomembrane until acceptance by the Owner or it's representatives. The Owner shall accept the geomembrane liner when all of the following conditions are met:

1. Installation is finished
2. Verification of the adequacy of all field seams and repairs, including associated testing is complete.
3. Customer, Owner or representative shall sign a completion report verifying the above.

11. STORAGE OF "AS BUILT" DRAWINGS

All as-builts are available shortly after completion of the project and can be copied out to the appropriate parties at request.