Layfield Group of Companies

Geomembrane Manufacturing Quality Assurance Manual
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1. Introduction

This manual describes the processes and system controls for the manufacture of geomembrane products. These controls are embedded in the Layfield Quality System.

2. The Layfield Group of Companies

The Layfield Group is a vertically integrated manufacturer, fabricator, installer and distributor of Geomembranes and Geosynthetics.

Layfield Environmental Containment is one of three business units of Layfield Group. It operates with its own sales, marketing and product development teams. The operation of Layfield Environmental Containment is shared across two legal entities: Layfield USA Corp. and Layfield Canada Ltd.

2.1. Statement of Qualifications

Layfield Group has been manufacturing polyethylene film since 1983. Over the years, Layfield has invested in product innovation, technology and acquisitions to continuously expand its capacity and diversify its product offerings. The most recent acquisitions are the extrusion line of major width designed to produce standard grade and high performance geomembranes and a state-of-the-art roll-to-roll automated fabrication machine that can weld up to 5 panels wide.

2.2. Layfield USA Corp.

Layfield USA Corp is Layfield’s operating company in the United States. Fabrication and installation activities are coordinated from a facility in San Diego, California. The distribution of stock and custom fabricated geomembranes and related products is coordinated out of facilities in Seattle, Washington; North Dakota and West Virginia.

2.3. Layfield Canada Ltd.

Layfield Canada Ltd. is Layfield’s operating company in Canada. The geomembrane liners are manufactured at the Richmond, British Columbia facility. The fabrication and installation activities are coordinated from facilities in Edmonton, Alberta and Toronto, Ontario. The distribution of stock and custom fabricated geomembranes and other related products is coordinated out of the facilities and warehouses in Edmonton and Calgary Alberta, in Toronto Ontario and in Richmond British Columbia.
3. Commitment to Quality

Layfield Group is committed to provide a dependable supply of products and services that consistently meet the customer’s expectations and all applicable product-specific standards. All business units of Layfield Group operate on a quality business management system that is certified to an international standard ISO-9001:2008. The Certificate of Registration for Layfield’s quality management system is attached in Appendix A – Certificate of Registration to ISO 9001:2008.

4. Product Development and Commercialization

The development and innovation of products is carried out through a robust product development and commercialization process. Verification and validation experimental runs are performed to confirm that the process produces consistent results and the product meets design specifications before proceeding to full scale commercialized production.

5. Quality Organization

Layfield’s Quality team consists of a Quality Manager, Engineering Manager and Process Engineers, Quality Assurance/Quality Control Coordinators, Quality testing facilities and manufacturing personnel.

The team is responsible for ensuring the system is functioning correctly, that raw material and finished goods inspections are being conducted according to established protocols, and that established identification and traceability standards are maintained.

5.1. Quality Personnel

<table>
<thead>
<tr>
<th>Team Member</th>
<th>Main Responsibilities</th>
</tr>
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<tbody>
<tr>
<td>Quality Manager</td>
<td>Maintenance and improvement of the MQA program. Development and approval of all raw material and finished sheet inspection plans.</td>
</tr>
<tr>
<td>Engineering Manager, Process Engineers</td>
<td>Product development and commercialization, including verification and validation trials. Approval of raw material specifications. Development and approval of all finished sheet product specifications.</td>
</tr>
</tbody>
</table>
| Quality Assurance / Quality Control Coordinators | Product testing  
|                                               | System and process auditing  
|                                               | Training of manufacturing personnel  
|                                               | System reporting  
| Manufacturing Personnel                        | Product testing  
|                                               | Product identification and traceability |

**5.2. Quality Facilities**

Layfield’s manufacturing facilities maintain high capacity testing laboratories outfitted with modern equipment capable of performing all referenced tests.

Layfield also utilizes an electronic Quality Management database to house all of its raw material product specifications, raw material and finished sheet product inspection plans and records, and related process inspection data.

**6. Quality Assurance**

**6.1. Incoming Raw Materials**

Layfield Group has developed and maintains full specifications for the resins used in the manufacture of geomembrane sheet.

**6.1.1. Resins**

Resins are the base polyolefin materials used in the manufacture of geomembrane sheeting. Each resin lot is provided with a product quality certification from the vendor. All incoming resins are inspected and tested prior to production use. Inspection results are entered into Layfield’s electronic Quality Management database.

Layfield has developed clear policies for the identification and traceability of resin material to ensure that only tested and approved materials are used in the manufacture of geomembrane sheet.

Appendix B – Raw Material Inspection Protocol provides a summary of the resin inspection protocol.
6.1.2. Additive Masterbatches

Various additive masterbatches are blended with natural resins in different proportions to achieve the desired properties of geomembrane sheet. All masterbatches are purchased and verified against the approved material specifications before these are released to manufacturing.

6.2. Product Identification and Traceability

Layfield has developed a system to identify the geomembrane products. Each geomembrane product is assigned with a unique product identifier or stock keeping unit (SKU). An enterprise resource planning (ERP) software is utilized to manage these product identifiers.

Each geomembrane roll is labeled with the product identifier, job number, roll number and the product description. Details of the labeling specifications are provided in Appendix E - Finished Product Packaging and Labeling.

Any geomembrane roll that does not meet the product specifications is identified and segregated to prevent its release or delivery. The electronic quality system database maintains the records of non-conforming geomembrane products.

The traceability of raw materials and geomembrane product lot is maintained in the electronic quality system database and the ERP software.

7. Quality Control

7.1. Quality Control Capabilities

Layfield’s manufacturing facilities maintain a quality control system with capabilities anchored on three facets:

- **PEOPLE** the required testing are performed by highly capable and well trained personnel
- **EQUIPMENT** state-of-the-art equipment that is suitable for performing the required product testing
- **METHODS** industry standard test methods are employed to monitor the product quality
7.2. Sampling and Inspection Plans

Layfield has instituted a product inspection system that is guided by industry standards and by customer requirements.

A geomembrane lot must meet both the sampling and inspection requirements to qualify for shipment. Appendix C – Finished Geomembrane Sampling and Testing Specifications defines the minimum sampling and testing protocol for all geomembrane products.

A selection of roll samples from each manufacturing lot is retained should future testing be required. These samples have the same label information as the geomembrane rolls. The storage method prevents the deterioration of the samples.

7.3. Inspection Records

Layfield maintains an electronic quality system database to collect, store and analyze the inspection data. Real-time inspection data are available to different work groups within the organization.

Layfield can provide signed mill certificates for each geomembrane lot or roll produced. The mill certificate provides the actual results for the specified quality attributes and validates that each product meets the geomembrane roll specifications as published on the Layfield website. Appendix D – Geomembrane Roll Specifications provide the links to the Layfield website.

7.4. Verification and Approval

The Layfield quality system requires that the test results have to be reviewed and signed off by approving authorities prior to shipment. This prevents the shipping of geomembrane rolls that do not meet the product specifications.

The electronic quality system database indicates the status of a geomembrane roll. The database is integrated with the shipping ERP software.

When necessary, an independent verification is carried out by an external laboratory. The selection of a third-party laboratory is done in concurrence with the customer requirements.
8. Finished Product Packaging and Labeling

The packaging and labeling specifications are communicated to the production group through the job docket system.

The geomembrane rolls are weather resistant and do not require further packaging. The minimum packaging and labeling requirements are indicated in Appendix E – Finished Geomembrane Packaging and Labeling Specifications.

9. Records Control and Documentation

The documentation required to effectively implement the quality system are electronically controlled and maintained.

The majority of the quality and manufacturing records are maintained electronically. A back-up and redundancy protocol is in placed to ensure that electronic records are available and protected.

The quality system defines the accountability, method and retention period for all paper-based quality and manufacturing records.

10. Revision History

<table>
<thead>
<tr>
<th>Revision Date</th>
<th>Revision Author</th>
<th>Revision Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>January 2015</td>
<td>S. Mitchell</td>
<td>First Issue</td>
</tr>
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</table>
Appendix A – Certificate of Registration to ISO 9001:2008

CERTIFICATE OF REGISTRATION

This is to certify that
Layfield Group Limited
11120 Silversmith Place, Richmond, British Columbia V7A 5E4 Canada

Refer to Attachment to Certificate of Registration dated August 11, 2014 for additional certified sites

operates a

Quality Management System

which complies with the requirements of

ISO 9001:2008

for the following scope of registration

The registration covers the Quality Management System for the design, manufacture, and distribution of flexible packaging, construction & agricultural films, geomembrane & geotextile products and environmental containment systems

Certificate No.: CERT-0080032
File No.: 1617729
Issue Date: August 11, 2014

Original Certification Date: November 8, 2010
Current Certification Date: August 9, 2014
Certificate Expiry Date: August 8, 2017

Chris Jouppi
President,
QCI- Sai Canada Limited

Samer Chaouk
Head of Policy, Risk and Certification

ISO 9001

Registered by SAI Global Certification Services Pty Ltd., 366 George Street, Sydney NSW 2000 Australia with SAI Global Canada Limited, 55 Parliament Court, Suite 200, Toronto, Ontario M5J 2L5. This certificate is subject to the SAI Global Terms and Conditions for Certification. Where at any time the certificate holder fails to maintain a compliant status, the certificate holder may be terminated. The certificate holder is the property of SAI Global and must be returned upon demand upon request.

To verify that this certificate is current, please refer to the SAI Global Online Certification Register: www.sai-global.com/ief_cert_search.
## ATTACHMENT TO
### CERTIFICATE OF REGISTRATION

These sites are registered under Certificate No. CERT-0080032 issued on August 11, 2014

<table>
<thead>
<tr>
<th>File No.</th>
<th>Company Name</th>
<th>Address</th>
<th>Effective Date</th>
</tr>
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<tr>
<td>1044436</td>
<td>Layfield Canada Ltd</td>
<td>17720-129 Ave NW, Edmonton, Alberta T5V 0D4 Canada</td>
<td>August 9, 2014</td>
</tr>
<tr>
<td>1044438</td>
<td>Layfield Canada Ltd</td>
<td>11891 Hammersmith Way, Richmond, British Columbia V7A 5E5 Canada</td>
<td>August 9, 2014</td>
</tr>
<tr>
<td>1044439</td>
<td>Layfield Canada Ltd</td>
<td>Bay 5 - 10551 50th Street SE, Calgary, Alberta T2C 3E3 Canada</td>
<td>August 9, 2014</td>
</tr>
<tr>
<td>1044440</td>
<td>Layfield Canada Ltd</td>
<td>117 Basaltic Road, Vaughan, Ontario L4K 1G4 Canada</td>
<td>August 9, 2014</td>
</tr>
<tr>
<td>1044441</td>
<td>Layfield USA Inc</td>
<td>4001 Oakesdale Avenue SW Suite 200, Renton, Washington 98057-4818 USA</td>
<td>August 9, 2014</td>
</tr>
<tr>
<td>1047015</td>
<td>Layfield Canada Ltd.</td>
<td>11120 Silversmith Place, Richmond, British Columbia V7A 5E4 Canada</td>
<td>August 9, 2014</td>
</tr>
<tr>
<td>1068774</td>
<td>Layfield USA Inc</td>
<td>110 - 2500 Sweetwater Springs Blvd, Spring Valley, California 91978 USA</td>
<td>August 9, 2014</td>
</tr>
<tr>
<td>1604881</td>
<td>Layfield Canada Ltd</td>
<td>11891 Hammersmith Way, Richmond, British Columbia V7A 5E5 Canada</td>
<td>August 9, 2014</td>
</tr>
</tbody>
</table>

These registrations are dependent on Layfield Group Limited (File No. 1617729) maintaining their scope of registration to ISO 9001:2008
## Appendix B – Raw Material Inspection Protocol

Table 1 - Minimum Resin Inspection Frequencies

<table>
<thead>
<tr>
<th>Property</th>
<th>Test Method</th>
<th>Test Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density</td>
<td>ASTM D1505</td>
<td>Once per railcar (= 200,000 lbs)</td>
</tr>
<tr>
<td>Melt Index</td>
<td>ASTM D1238</td>
<td>Once per railcar (= 200,000 lbs)</td>
</tr>
<tr>
<td>Colour Inspection</td>
<td>Internal method</td>
<td>Once per railcar compartment (= 50,000 lbs)</td>
</tr>
<tr>
<td>Contamination Inspection</td>
<td>Internal method</td>
<td>Once per railcar compartment (= 50,000 lbs)</td>
</tr>
<tr>
<td>Presence of fines and streamers</td>
<td>Visual inspection</td>
<td>Once per railcar compartment (= 50,000 lbs)</td>
</tr>
<tr>
<td>Integrity of seals on caps and hatches</td>
<td>Visual inspection</td>
<td>Once per railcar compartment (= 50,000 lbs)</td>
</tr>
</tbody>
</table>

12. **Figure 1-a**: Sampling Process of Railcar Inspection  
12. **Figure 1-b**: Railcar being released after inspection
## Appendix C – Finished Geomembrane Sampling and Testing Specifications

Table 2 – Enviro Liner 6000HD - smooth and textured liners

<table>
<thead>
<tr>
<th>Property</th>
<th>Test Method</th>
<th>Test Frequency</th>
<th>Test Frequency</th>
<th>Test Frequency</th>
<th>Number of Specimen per test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thickness</td>
<td>ASTM D5199</td>
<td>Every roll</td>
<td>Every roll</td>
<td>Every roll</td>
<td>10</td>
</tr>
<tr>
<td>Asperity (for textured liner only)</td>
<td>ASTM D7466</td>
<td>Every 2 rolls</td>
<td>Every 2 rolls</td>
<td>Every 2 rolls</td>
<td>10 for each textured side</td>
</tr>
</tbody>
</table>
| Density                          | ASTM D1505        | Every 200,000 lbs  
90 rolls       | Every 200,000 lbs  
80 rolls       | Every 200,000 lbs  
50 rolls       | 1                           |
| Tensile Properties               | ASM D6693 IV, ASTM D638 | Every 9 rolls  | Every 7 rolls  | Every 5 rolls  | 5 for each MD (machine direction) and TD (transverse direction) |
| Tear Resistance                  | ASTM D1004        | Every 18 rolls  | Every 14 rolls  | Every 10 rolls  | 5 for each MD (machine direction) and TD (transverse direction) |
| Puncture Resistance              | ASTM D4833        | Every 18 rolls  | Every 14 rolls  | Every 10 rolls  | 5                           |
| Carbon Black Content             | ASTM D1603        | Every 18 rolls  | Every 14 rolls  | Every 5 rolls  | 1                           |
| Carbon Black Dispersion          | ASTM D5596        | Every 18 rolls  | Every 14 rolls  | Every 10 rolls  | 10 views                     |
| High Pressure Oxidative          | ASTM D5885        | Every 200,000 lbs  
90 rolls       | Every 200,000 lbs  
80 rolls       | Every 200,000 lbs  
50 rolls       | 1                           |
| Induction Time                   |                   |                |                |                |                             |
| Sheet Width                      | Internal method   | Every roll     | Every roll     | Every roll     | 1                           |

*The same requirements are applicable to other product types: Enviro Liner 4000, Enviro Liner 7000, Geoflex & HAZGARD 635FR.*

Table 3 – HDPE - smooth and textured liners
<table>
<thead>
<tr>
<th>Property</th>
<th>Test Method</th>
<th>Test Frequency</th>
<th>Number of Specimen per test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Roll Width = 148” AND BELOW</td>
<td>Roll Width = 149” to 210”</td>
</tr>
<tr>
<td>Thickness</td>
<td>ASTM D5199</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Asperity (for textured liner only)</td>
<td>ASTM D7466</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Density</td>
<td>ASTM D1505</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Tensile Properties</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Yield Strength</td>
<td>ASTM D6693 IV</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>• Break strength</td>
<td>ASTM D638</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>• Yield Elongation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Break elongation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tear Resistance</td>
<td>ASTM D1004</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Puncture Resistance</td>
<td>ASTM D4833</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Carbon Black Content</td>
<td>ASTM D1603</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Carbon Black Dispersion</td>
<td>ASTM D5596</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>High Pressure Oxidative Induction Time</td>
<td>ASTM D5885</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Sheet Width</td>
<td>Internal method</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Table 4 – Enviro Liner 3000 and 1000 – smooth and textured liners
<table>
<thead>
<tr>
<th>Property</th>
<th>Test Method</th>
<th>Test Frequency</th>
<th>Number of Specimen per test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thickness</td>
<td>ASTM D5199</td>
<td>Every roll, N/A, Every roll</td>
<td>10</td>
</tr>
<tr>
<td>Asperity (for textured liner only)</td>
<td>ASTM D7466</td>
<td>Every 2 rolls, N/A, Every 2 rolls</td>
<td>10 for each textured side</td>
</tr>
<tr>
<td>Density</td>
<td>ASTM D1505</td>
<td>Every 30 rolls, N/A, Every 30 rolls</td>
<td>1</td>
</tr>
<tr>
<td>Tensile Properties</td>
<td>ASTM D6693 IV, ASTM D638</td>
<td>Every 30 rolls, N/A, Every 30 rolls</td>
<td>5 for each MD, TD</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(machine direction) and TD (transverse direction)</td>
</tr>
<tr>
<td>Tear Resistance</td>
<td>ASTM D1004</td>
<td>Every 30 rolls, N/A, Every 30 rolls</td>
<td>5 for each MD, TD</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(machine direction) and TD (transverse direction)</td>
</tr>
<tr>
<td>Puncture Resistance</td>
<td>ASTM D4833</td>
<td>Every 30 rolls, N/A, Every 30 rolls</td>
<td>5</td>
</tr>
<tr>
<td>Carbon Black Content</td>
<td>ASTM D1603</td>
<td>Every 30 rolls, N/A, Every 30 rolls</td>
<td>1</td>
</tr>
<tr>
<td>Carbon Black Dispersion</td>
<td>ASTM D5596</td>
<td>First roll per production lot, N/A, First roll per production lot</td>
<td>10 views</td>
</tr>
<tr>
<td>High Pressure Oxidative Induction Time</td>
<td>ASTM D5885</td>
<td>First roll per production lot, N/A, N/A</td>
<td>1</td>
</tr>
<tr>
<td>Sheet Width</td>
<td>Internal method</td>
<td>Every roll, N/A, N/A</td>
<td>1</td>
</tr>
</tbody>
</table>
Appendix D – Geomembrane Roll Specifications

The specifications are published on the Layfield website.

Enviro Liner 6000 HD

HDPE

Enviro Liner 7000

Enviro Liner 4000

Enviro Liner 3000

Enviro Liner 1000

Enviro Liner 6000 HD Textured

Enviro Liner 4000 Textured

HAZGARD 635FR
https://www.layfieldgroup.com/Geosynthetics/Geomembranes/HAZGARD-635FR.aspx

GEOFLEX
https://www.layfieldgroup.com/Geosynthetics/Geomembranes/GeoFlex.aspx
Appendix E – Finished Geomembrane Packaging and Labeling Specifications

The minimum packaging and labeling requirements for a geomembrane roll are:

1. Plastic straps tied on the centre and on both ends of the roll width to secure the end wrap of the roll.

2. Five (5) labels are placed on the following locations:
   a. One label under the end wrap
   b. One label on top of the end wrap and center of the roll width
   c. One label on each side of the roll (see pictures below)
   d. One label for the retained sample
3. The minimum information on the label are:
   a. Customer identification & purchase order number
   b. Product or SKU description
   c. Roll serial number (configured as Product or SKU number-lot number-roll number)
   d. Product dimensions (thickness, width and length)
   e. Roll gross and net weight
   f. Product Certification Information (as applicable)
   g. Layfield customer service number