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1.0 INTRODUCTION
This manual provides an overview of the GSE Manufacturing Quality Assurance Program for GSE nonwoven geotextile products. It is intended for use by GSE’s customers to enhance their understanding of the quality system under which GSE nonwoven geotextile products are manufactured.

2.0 COMMITMENT TO QUALITY
GSE is committed to meeting or exceeding customer’s requirements and industry standards. This commitment to quality is established through a documented quality management system, continuous employee training, investment in technology and emphasis on process control. GSE has allocated resources to ensure that this commitment to quality translates into the best products and services for its customers.

3.0 MANUFACTURING QUALITY ASSURANCE
GSE has an on-site quality assurance laboratory at each manufacturing facility worldwide. Each facility has a fully equipped, well staffed, dedicated laboratory with strict guidelines to maintain a high level of quality and up-to-the-minute results on GSE’s finished products.

GSE has a rigorous set of minimum standards and an effective test program to assure compliance has been established. These procedures and requirements are frequently reviewed and adjusted to assure compliance with current market demands and/or predetermined project specifications. Also raw materials and process parameters are controlled to provide products complying with GSE’s minimum characteristics and regulatory standards.

4.0 MANUFACTURING QUALITY ASSURANCE ORGANIZATION
GSE quality assurance department assures that only products meeting GSE and/or the customer’s requirements are released for shipment. The quality assurance personnel are directly responsible for monitoring, testing, and providing feedback to the manufacturing department ensuring the production of the specified product quality.

Each member of the quality assurance team must participate in detailed training that includes factory exposure. The GSE quality assurance team consists of the manufacturing quality assurance laboratories, engineering staff and manufacturing personnel. The combination of expertise and experience from these groups provide GSE with the proper tools to maintain the highest level of product quality and customer service in the industry.

5.0 STAFF & SCHEDULING
The quality assurance laboratories are staffed during any manufacturing run. A continuous communication link is maintained between the laboratory and manufacturing personnel, maximizing production efficiency and product quality.

6.0 PRODUCT IDENTIFICATION & DOCUMENTATION
A. Roll Numbering
   Each roll of geotextile is assigned a unique roll number. The quality assurance laboratory maintains records documenting the raw materials and resulting product quality information.

B. Approval Procedure
   Results for each tested roll of product are checked against both GSE and/or customer’s specifications for compliance. The quality assurance laboratory approves those materials that meet these requirements for shipment.

C. Non-Conformance
   Material that does not meet GSE’s minimum standards is given a roll number, but is rejected and separated from the approved material. The rejected material is then identified as non-conforming and will not be used. Material that meets GSE’s minimum standards, but does not meet a stricter customer’s specifications will not be allocated to that customer, but will be placed into inventory as a GSE’s standard material.
D. Documentation

Quality assurance certificates are generated and supplied for each roll of geotextile product to include all relevant quality assurance information about the material.

7.0 RECORDS RETENTION

GSE maintains reports and/or samples for products produced and sold. Records and/or samples are maintained according to GSE's standard retention policy as outlined below.

<table>
<thead>
<tr>
<th>MATERIAL</th>
<th>ITEM</th>
<th>YEAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geotextiles</td>
<td>Raw Test Data (in computer database)</td>
<td>≥ 5</td>
</tr>
<tr>
<td></td>
<td>Quality Control Certificates (in computer database)</td>
<td>≥ 5</td>
</tr>
<tr>
<td></td>
<td>Sample Retain (approximately one square foot)</td>
<td>≥ 5</td>
</tr>
</tbody>
</table>

8.0 TESTING CAPABILITIES

GSE maintains high capacity, state-of-the-art laboratory equipment suitable for performing the appropriate test procedures in Houston, Texas, and Kingstree, South Carolina. Both quality assurance laboratories are accredited by the GAI-LAP Program. The appropriate certificates are maintained for review upon request by authorized parties.

A. Routine Testing

GSE has developed a strict quality assurance program, which exceeds all industry’s standard practices and/or customer’s specifications. The testing process covers raw materials and finished goods and is adhered to by all GSE’s quality assurance laboratories. The laboratory equipment used by GSE represents the most modern equipment available and it meets or exceeds the requirements of all the test standards used. Test frequencies and number of test specimen per sample are established based on statistical analysis and complexity of procedures.

B. Other Testing Capabilities

In addition to routine testing, GSE’s laboratories are equipped to perform a wide variety of other tests as required for unusual requests or product development. Further, although the GSE’s laboratories are fully equipped and able to perform most routinely specified tests in the industry, there are some tests that are more economically performed by a dedicated testing facility. GSE believes requirements for such testing should be carefully considered and defined in terms of specific design requirements if they are found to be necessary.

9.0 MATERIAL QUALITY ASSURANCE

GSE has established strict specifications for all raw materials and finished products. Test results must fall within the acceptable limits of GSE and/or customer’s specifications.

A. Receiving Inspection and Testing

GSE utilizes only prime quality staple fiber purchased from approved outside suppliers. Fiber suppliers are required by GSE to provide a Certificate of Analysis (COA) for each shipment of fiber prior to being utilized in production.

The lab manager ensures that fiber received by the company meets the specified requirements. Requirements for fiber properties are listed in GSE’s quality system documents and are communicated to suppliers on the purchase order. Any fiber lot not meeting the specified requirements is either returned to the supplier or regraded.

B. Multiple In-Line Metal Detectors

One of GSE's top priorities is to supply products to its customers free of any metal contamination. This is accomplished through multiple in-line metal detectors. GSE uses state-of-the-art metal detection technologies for this purpose. A letter sample from our Plant Manager, emphasizing GSE’s commitment to a metal-free product, is shown in Appendix A.
C. Integrated Automatic Mass Distribution Control
GSE uses an in-line automatic mass distribution control system. An in-line sensor continuously measures mass distribution across roll width and feeds that information to an integrated process control system. If the product mass deviates from the maximum allowable variation, the process control system automatically makes the necessary adjustments to bring the product back to the required range. Using this in-line sensor and the integrated process control system, GSE produces the most consistent and uniform product available in the industry.

D. In-line Illuminated Visual Inspection Panel
The illumination panel used for visual inspection enhances the ability to inspect the product and monitor the process during manufacturing. The panel provides an opportunity to detect any defect that would otherwise not be apparent to the naked eye. In the event a defect is noted, the roll in question is marked and eliminated.

E. Sampling and Testing
To be approved for shipment, all products must meet GSE’s minimum requirements and/or customer’s specifications. With respect to both frequency of testing and test values, GSE’s internal requirements are usually more stringent than project or customer’s specifications. GSE regularly performs the following tests on its products:
  • Mass per Unit Area, ASTM D 5261
  • Grab Tensile Strength and Elongation, ASTM D 4632
  • Trapezoidal Tear Strength, ASTM D 4533
  • Puncture Strength, ASTM D 4833
  • Apparent Opening Size, ASTM D 4751
  • Permittivity and Water Flow Rate, ASTM D 4491
Nonwoven geotextile rolls are sampled for quality assurance testing according to frequencies in Appendix B. An approximate one foot by roll width sample is cut for quality assurance testing. Test specimens are taken from five positions across the width of the roll. A retain or archive sample approximately 12 x 12 in (30 x 30 cm) is taken from one of the five positions on an alternating basis. The retain sample is labeled and kept for future reference.

F. Product Shipping
It is GSE’s policy to ship only products that have been tested and approved. All shipments are packaged according to industry’s standard practices and/or customer’s specifications. Only approved handling methods are used to move rolls into and out of shipping containers, please see the GSE Installation Quality Assurance Manual for more details.
Appendix A: Needle-Free Statement

May 11, 2009

To Whom it May Concern:

RE: “Needle-Free” Statement for GSE Nonwoven Geotextiles

GSE takes intensive process and quality control measures to ensure that our nonwoven needlepunched geotextiles are free from broken needles and other metal objects. We have two metal detection systems working in series to achieve this objective.

The first metal detector is placed between the fiber supply and the card. At this point any metal in the fiber supply is detected and prevented from passing on to the production line. The second detector is located after the needle looms. This industrial strength magnetic system spans the entire width of the geotextile. Should a metal piece or a broken needle be detected by the system, an alarm alerts the operator. The contaminated part of the geotextile is eliminated by the operator.

With the above system in place, GSE is confident that all our nonwovens are needle-free.

Sincerely,

Dino Heathcott
Plant Manager
Appendix B: Minimum Testing Frequencies For GSE Geotextile Products

<table>
<thead>
<tr>
<th>PROPERTY</th>
<th>TEST METHOD</th>
<th>GEOTEXTILE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mass per Unit Area</td>
<td>ASTM D 5261</td>
<td>1 per 90,000 ft²</td>
</tr>
<tr>
<td>Grab Tensile Strength and Elongation</td>
<td>ASTM D 4632</td>
<td>1 per 90,000 ft²</td>
</tr>
<tr>
<td>Trapezoidal Tear Strength</td>
<td>ASTM D 4533</td>
<td>1 per 90,000 ft²</td>
</tr>
<tr>
<td>Puncture Strength</td>
<td>ASTM D 4833</td>
<td>1 per 90,000 ft²</td>
</tr>
<tr>
<td>Apparent Opening Size</td>
<td>ASTM D 4751</td>
<td>1 per 540,000 ft²</td>
</tr>
<tr>
<td>Permittivity and Water Flow Rate</td>
<td>ASTM D 4491</td>
<td>1 per 540,000 ft²</td>
</tr>
</tbody>
</table>
GSE is a leading manufacturer and marketer of geosynthetic lining products and services. We’ve built a reputation of reliability through our dedication to providing consistency of product, price and protection to our global customers.

Our commitment to innovation, our focus on quality and our industry expertise allow us the flexibility to collaborate with our clients to develop a custom, purpose-fit solution.

For more information on this product and others, please visit us at GSEworld.com, call 800.435.2008 or contact your local sales office.

(DURABILITY RUNS DEEP)