Manufacturing Quality Assurance Manual

Geomembrane Products

GSE

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1.0 INTRODUCTION

This manual provides an overview of the GSE Manufacturing Quality Assurance Program for geomembrane products. It is intended for use by GSE's customers to enhance their understanding of the quality system under which GSE geomembrane 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.

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6.0 PRODUCT IDENTIFICATION & DOCUMENTATION

A. Roll Numbering

Each roll of geomembrane 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 GSE and/or customer's specifications for compliance. The quality assurance laboratory approves those materials that meet both of 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 identified as non-conformaning 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 geomembrane 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.

MATERIAL	ITEM	YEAR
Raw Materials	Resin Supplier Test Reports and Certifications GSE Resin Test Reports Resin Sample Retain (Archive)	≥ 2 ≥ 2 ≥ 2
Geomembranes	Raw Test Data (in computer database) Quality Control Certificates Sample Retain (approximately one square foot)	≥ 5 ≥ 5 ≥ 5

8.0 TESTING CAPABILITIES

GSE maintains high capacity, state-of-the-art laboratory equipment suitable for performing the procedures listed in Appendixes A-H in Houston, Texas. The quality assurance laboratory is 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 and thorough quality assurance program, which exceeds all industry's standards and/or customer's specifications including GRI GM13, "Test Properties, Testing Frequency

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and Recommended Warranty for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes and GRI GM17 Test Properties, Testing Frequency and Recommended Warranty for Linear Low Density Polyethylene (LLDPE) Smooth and Textured Geomembranes. The testing program covers raw materials as shown in Appendix A and the finished goods as shown in Appendixes B-H and is adhered to by all GSE's quality assurance laboratories. The laboratory equipment used by GSE represents the most modern equipment available and meets or exceeds the requirements of all the test standards used.

B. Other Testing Capabilities

In addition to routine testing, GSE 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 the 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 customer's specifications.

A. Raw Material

GSE uses two types of raw materials in the manufacture of geomembrane products: natural resin and masterbatch . Natural resin is the base material that is used to make a geomembrane. It contains stabilizers to prevent degradation from occurring during and after extrusion. Masterbatch is the term referring to the concentrated carbon black material blended with the natural resin to produce the finished product. The natural resin and masterbatch are blended at the appropriate ratio at the manufacturing stage. The masterbatch can contain other additives depending upon the geomembrane product to be produced. GSE verifies the properties of each lot of raw material prior to their utilization.

When natural resin is received, samples are taken and subjected to the tests outlined in Appendix A. All test data are entered into the computer database and checked for accuracy, consistency and compliance with GSE's specifications. The material is not accepted unless all standard test requirements are met and the GSE's test values meet the requirements set forth in the raw material specifications.

Copies of the supplier's certificate of analysis (COA) for each lot of resin utilized in the production of the materials supplied to a specific project are supplied as standard documentation. In addition, the GSE's test results for each lot of resin are provided in a separate report upon request. Virgin resin is normally received in rail car lots. If resin is received by other transport and/or in other quantities, an equivalent suitable sampling procedure is provided (i.e. not less than one sample per shipment or one sample for each 50,000 lb, 23,000 kg).

B. Geomembrane Products

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GSE has implemented a strict and thorough quality assurance program for all geomembrane products. The geomembrane product line can be broken into two primary categories: smooth and textured products. The tables contain GSE's minimum properties and test frequencies for all GSE geomembrane products, such as GSE Green (green surface geomembrane), GSE White (light-reflective geomembrane) and GSE Conductive (field spark-testable geomembrane) as shown in Appendixes B-H.

1. On-Line Manufacturing Quality Assurance
   The quality assurance program for finished product begins during the manufacturing process. Each manufacturing line is equipped with state-of-the-art monitoring devices that provide feedback on the physical quality of the materials being produced. Each geomembrane production line is equipped with both a thickness gauge and spark-testing device.

   a. Thickness Measurement
      As geomembrane is being produced, thickness readings are taken continuously over the length and width of the roll. These data are used to establish the minimum, maximum and average thickness values for each roll and are verified by thickness testing upon sampling of the finished goods.

   b. Spark Testing
      An electrical spark detector is in place on each manufacturing sheet line. This apparatus provides immediate notification of holes in the finished product. If a hole is detected, an alarm is triggered and the hole is identified. Rolls containing holes are rejected from standard product inventory.

2. Smooth Geomembrane Materials
   Smooth geomembrane products available include high density and linear low density polyethylene materials with 2-3% carbon black. Specialty materials include GSE White, GSE Conductive, and GSE Green geomembranes.

   a. Sampling
      Geomembrane rolls are sampled for QA testing according to the 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 in x 12 in (30 cm x 30 cm) is taken one of the five positions on an alternating basis from the laboratory sample. The retain is labeled and kept for future reference.

   b. Evaluation of Results
      All data are entered into a computer database for calculation and comparison to GSE and/or customer's specifications. If materials do not meet GSE's minimum requirements and/or the customer's specifications, the manufacturing personnel will appropriately make the adjustments. Only products meeting GSE's minimums and/or customer's specifications will be approved for shipment.

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c. Reporting

Every roll of material has a quality assurance roll certificate or Roll Test Data Report (RTDR). This report identifies the standards on which the GSE's approval is based along with the actual test results demonstrated by the material.

3. Co-extruded Textured Geomembranes

Textured geomembrane is produced utilizing a round die with co-extrusion technology. The texture is produced in a process in which one or both of the outer layers of a three-layer extrusion are blended with nitrogen gas. Nitrogen bubbles form in the molten resin and escape upon exiting the die, creating a rough, textured surface. GSE standard, GSE White, GSE Green, and GSE Conductive geomembranes are available with co-extruded texturing.

a. Sampling

Geomembrane rolls are sampled for QA testing according to the frequencies in Appendixes B-H. An approximate one-foot by roll width sample is cut for quality assurance testing. Specimens for testing are taken from five positions across the width of the roll. Specimens for testing the machine and transverse direction tensile are cut from each of the five positions. A retain or archive sample approximately 12 in x 12 in (30 cm x 30 cm) is taken from the corresponding transverse direction position from the laboratory sample. The retain is labeled and kept for future reference. Evaluation of results and reporting practices are the same as for smooth geomembranes.

C. Third Party Conformance Sampling

Some specifications require independent quality assurance and/or conformance testing. GSE can provide assistance with the sampling of products by arranging for the conformance samples to be taken during production. By taking samples during production rather than on-site or after production, the customer can be assured that the samples are clean and available for conformance testing in a timely manner.

GSE encourages customers to audit GSE manufacturing and other manufacturing quality assurance facilities to collect samples and conduct independent conformance testing prior to shipment of materials.

D. 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.

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Appendix A: Minimum Testing Frequencies and Properties for GSE Raw Materials

TABLE 1. MINIMUM TESTING FREQUENCIES

Property	Test Method[1]	Natural Resin
Density	ASTM D 1505	once per rail car compartment
Melt Flow Index	ASTM D 1238 (190/2.16)	once per rail car compartment
OIT	ASTM D 3895 (1 ATM at 200° C)	once per resin lot[2]
Carbon Black Content	ASTM D 1603, modified	N/A
Carbon Black Dispersion	ASTM D 5996	NA

NOTES:

[1]GSE utilizes test equipment and procedures that enable effective and economical confirmation that the product will conform to specifications based on the noted procedures. Some test procedures have been modified for application to geosynthetics. All procedures and values are subject to change without prior notification.

[2]OIT for LLDPE/VFPE resin is performed on a representative finished product for each lot of resin rather than on the natural (without carbon black) resin.

TABLE 2. MINIMUM PROPERTIES FOR GSE RAW MATERIALS

Property	Test Method[1]	HDPE	LLDPE/VFPE
Density [g/cm^3]	ASTM D 1505	0.932	0.915
Melt Flow Index [g/10 min]	ASTM D 1238 (190/2.16)	≤ 1.0	≤ 1.0
OIT [minutes]	ASTM D 3895 (1 ATM at 200° C)	100	100[2]

NOTES:

[1]GSE utilizes test equipment and procedures that enable effective and economical confirmation that the product will conform to specifications based on the noted procedures. Some test procedures have been modified for application to geosynthetics. All procedures and values are subject to change without prior notification.

[2]OIT for LLDPE/VFPE resin is performed on a representative finished product for each lot of resin rather than on the natural (without carbon black) resin.

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Appendix B: GSE HD Smooth Data Sheet

Product Specifications

These product specifications meet or exceed GRI GM13.

TESTED PROPERTY	TEST METHOD	FREQUENCY	MINIMUM AVERAGE VALUE				
			30 mil	40 mil	60 mil	80 mil	100 mil
Thickness, (minimum average) mil (mm) Lowest individual reading (-10%)	ASTM D 5199	every roll	30 (0.75) 27 (0.69)	40 (1.00) 36 (0.91)	60 (1.50) 54 (1.40)	80 (2.00) 72 (1.80)	100 (2.50) 90 (2.30)
Density, g/cm^3	ASTM D 1505	200,000 lb	0.94	0.94	0.94	0.94	0.94
Tensile Properties (each direction)	ASTM D 6693, Type IV	20,000 lb					
Strength at Break, lb/in-width (N/mm)	Dumbell, 2 ipm		120 (21)	152 (26)	243 (42)	327 (57)	410 (71)
Strength at Yield, lb/in-width (N/mm)			66 (11)	84 (14)	132 (23)	177 (30)	212 (37)
Elongation at Break, %	G.L. 2.0 in (51 mm)		700	700	700	700	700
Elongation at Yield, %	G.L. 1.3 in (33 mm)		13	13	13	13	13
Tear Resistance, lb (N)	ASTM D 1004	45,000 lb	21 (93)	28 (124)	42 (186)	58 (257)	73 (324)
Puncture Resistance, lb (N)	ASTM D 4833	45,000 lb	65 (289)	85 (378)	125 (556)	160 (711)	195 (867)
Carbon Black Content, % (Range)	ASTM D 1603*/4218	20,000 lb	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0
Carbon Black Dispersion	ASTM D 5596	45,000 lb	Note(1)	Note(1)	Note(1)	Note(1)	Note(1)
Notched Constant Tensile Load, hr	ASTM D 5397, Appendix	200,000 lb	1,000	1,000	1,000	1,000	1,000
Oxidative Induction Time, min	ASTM D 3895, 200° C; O_2, 1 atm	200,000 lb	>140	>140	>140	>140	>140
TYPICAL ROLL DIMENSIONS							
Roll Length(2), ft (m)			1,120 (341)	870 (265)	560 (171)	430 (131)	340 (104)
Roll Width(2), ft (m)			22.5 (6.9)	22.5 (6.9)	22.5 (6.9)	22.5 (6.9)	22.5 (6.9)
Roll Area, ft^2 (m^2)			25,200 (2,341)	19,575 (1,819)	12,600 (1,171)	9,675 (899)	7,650 (711)

NOTES:

- (1)Dispersion only applies to near spherical agglomerates. 9 of 10 views shall be Category 1 or 2. No more than 1 view from Category 3.
- (2)Roll lengths and widths have a tolerance of ± 1%.
- GSE HD is available in rolls weighing approximately 3,900 lb (1,769 kg).
- All GSE geomembranes have dimensional stability of ±2% when tested according to ASTM D 1204 and LTB of <-77° C when tested according to ASTM D 746.
- *Modified.

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Appendix B: GSE HD Textured Data Sheet

Product Specifications

These product specifications meet or exceed GRI GM13.

TESTED PROPERTY	TEST METHOD	FREQUENCY	MINIMUM AVERAGE VALUE				
			30 mil	40 mil	60 mil	80 mil	100 mil
Thickness, (minimum average) mil (mm) Lowest individual reading (-10%)	ASTM D 5994	every roll	30 (0.75) 27 (0.69)	40 (1.00) 36 (0.91)	60 (1.50) 54 (1.40)	80 (2.00) 72 (1.80)	100 (2.50) 90 (2.30)
Density, g/cm³	ASTM D 1505	200,000 lb	0.94	0.94	0.94	0.94	0.94
Tensile Properties (each direction)	ASTM D 6693, Type IV	20,000 lb					
Strength at Break, lb/in-width (N/mm)	Dumbell, 2 ipm		66 (11)	75 (13)	115 (20)	155 (27)	230 (40)
Strength at Yield, lb/in-width (N/mm)			68 (11)	90 (15)	132 (23)	177 (31)	225 (39)
Elongation at Break, %	G.L. 2.0 in (51 mm)		100	100	100	100	100
Elongation at Yield, %	G.L. 1.3 in (33 mm)		12	12	12	12	12
Tear Resistance, lb (N)	ASTM D 1004	45,000 lb	24 (106)	32 (142)	45 (200)	60 (266)	75 (333)
Puncture Resistance, lb (N)	ASTM D 4833	45,000 lb	65 (289)	95 (422)	130 (578)	160 (711)	190 (845)
Carbon Black Content, % (Range)	ASTM D 1603*/4218	20,000 lb	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0
Carbon Black Dispersion	ASTM D 5596	45,000 lb	Note(1)	Note(1)	Note(1)	Note(1)	Note(1)
Asperity Height, mil (mm)	ASTM D 7466	second roll	16 (0.40)	18 (0.45)	18 (0.45)	18 (0.45)	18 (0.45)
Notched Constant Tensile Load(2), hr	ASTM D 5397, Appendix	200,000 lb	1,000	1,000	1,000	1,000	1,000
Oxidative Induction Time, min	ASTM D 3895, 200°C; O_2, 1 atm	200,000 lb	>140	>140	>140	>140	>140
TYPICAL ROLL DIMENSIONS							
Roll Length(3), ft (m)	Double-Sided Textured		830 (253)	700 (213)	520 (158)	400 (122)	330 (101)
	Single-Sided Textured		840 (256)	650 (198)	420 (128)	320 (98)	250 (76)
Roll Width(3), ft (m)			22.5 (6.9)	22.5 (6.9)	22.5 (6.9)	22.5 (6.9)	22.5 (6.9)
Roll Area, ft² (m²)	Double-Sided Textured		18,675 (1,735)	15,750 (1,463)	11,700 (1,087)	9,000 (836)	7,425 (690)
	Single-Sided Textured		18,900 (1,755)	14,625 (1,359)	9,450 (878)	7,200 (669)	5,625 (523)

NOTES:

- (1)Dispersion only applies to near spherical agglomerates. 9 of 10 views shall be Category 1 or 2. No more than 1 view from Category 3.
- (2)NCTL for GSE HD Textured is conducted on representative smooth membrane samples.
- (3)Roll lengths and widths have a tolerance of ± 1%.
- GSE HD Textured Double-Sided is available in rolls weighing approximately 4,000 lb (1,800 kg) and Single-Sided weighing approximately 3,000 lb (1,360 kg).
- All GSE geomembranes have dimensional stability of ±2% when tested according to ASTM D 1204 and LTB of <-77°C when tested according to ASTM D 746.
- *Modified.

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Appendix C: GSE Green Smooth Data Sheet

Product Specifications

These product specifications meet or exceed GRI GM13.

TESTED PROPERTY	TEST METHOD	FREQUENCY	MINIMUM AVERAGE VALUE				
			30 mil	**40 mil**	**60 mil**	**80 mil**	**100 mil**
Thickness, (minimum average) mil (mm)	ASTM D 5199	every roll	30 (0.75)	40 (1.00)	60 (1.50)	80 (2.00)	100 (2.50)
Lowest individual reading (-10%)			27 (0.69)	36 (0.91)	54 (1.40)	72 (1.80)	90 (2.30)
Density, g/cm^3	ASTM D 1505	200,000 lb	0.94	0.94	0.94	0.94	0.94
Tensile Properties (each direction)	ASTM D 6693, Type IV	20,000 lb					
Strength at Break, lb/in-width (N/mm)	Dumbell, 2 ipm		120 (21)	152 (26)	243 (42)	327 (57)	410 (71)
Strength at Yield, lb/in-width (N/mm)			66 (11)	84 (14)	132 (23)	177 (30)	212 (37)
Elongation at Break, %	G.L. 2.0 in (51 mm)		700	700	700	700	700
Elongation at Yield, %	G.L. 1.3 in (33 mm)		13	13	13	13	13
Tear Resistance, lb (N)	ASTM D 1004	45,000 lb	21 (93)	28 (124)	42 (186)	58 (257)	73 (324)
Puncture Resistance, lb (N)	ASTM D 4833	45,000 lb	65 (289)	85 (378)	125 (556)	160 (711)	195 (867)
Carbon Black Content[1], % (Range)	ASTM D 1603*/4218	20,000 lb	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0
Carbon Black Dispersion	ASTM D 5596	45,000 lb	Note[2]	Note[2]	Note[2]	Note[2]	Note[2]
Notched Constant Tensile Load, hr	ASTM D 5397, Appendix	200,000 lb	1,000	1,000	1,000	1,000	1,000
Oxidative Induction Time, min	ASTM D 3895, 200°C; O_2, 1 atm	200,000 lb	>140	>140	>140	>140	>140
TYPICAL ROLL DIMENSIONS							
Roll Length[3], ft (m)			1,120 (341)	870 (265)	560 (171)	430 (131)	340 (104)
Roll Width[3], ft (m)			22.5 (6.9)	22.5 (6.9)	22.5 (6.9)	22.5 (6.9)	22.5 (6.9)
Roll Area, ft^2 (m^2)			25,200 (2,341)	19,575 (1,819)	12,600 (1,171)	9,675 (899)	7,650 (711)

NOTES:

- [1]GSE Green may have an overall ash content greater than 3.0% due to the green layer. These values apply to the black layer only.
- [2]Dispersion only applies to near spherical agglomerates. 9 of 10 views shall be Category 1 or 2. No more than 1 view from Category 3.
- [3]Roll lengths and widths have a tolerance of ± 1%.
- GSE Green is available in rolls weighing approximately 3,900 lb (1,769 kg).
- All GSE geomembranes have dimensional stability of ±2% when tested according to ASTM D 1204 and LTB of <-77°C when tested according to ASTM D 746.
- *Modified.

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Appendix C: GSE Green Textured Data Sheet

Product Specifications

These product specifications meet or exceed GRI GM13.

TESTED PROPERTY	TEST METHOD	FREQUENCY	MINIMUM AVERAGE VALUE				
			30 mil	40 mil	60 mil	80 mil	100 mil
Thickness, (minimum average) mil (mm) Lowest individual reading (-10%)	ASTM D 5994	every roll	30 (0.75) 27 (0.69)	40 (1.00) 36 (0.91)	60 (1.50) 54 (1.40)	80 (2.00) 72 (1.80)	100 (2.50) 90 (2.30)
Density, g/cm^3	ASTM D 1505	200,000 lb	0.94	0.94	0.94	0.94	0.94
Tensile Properties (each direction)	ASTM D 6693, Type IV	20,000 lb					
Strength at Break, lb/in-width (N/mm)	Dumbell, 2 ipm		66 (11)	75 (13)	115 (20)	155 (27)	230 (40)
Strength at Yield, lb/in-width (N/mm)			68 (11)	90 (15)	132 (23)	177 (31)	225 (39)
Elongation at Break, %	G.L. 2.0 in (51 mm)		100	100	100	100	100
Elongation at Yield, %	G.L. 1.3 in (33 mm)		12	12	12	12	12
Tear Resistance, lb (N)	ASTM D 1004	45,000 lb	24 (106)	32 (142)	45 (200)	60 (266)	75 (333)
Puncture Resistance, lb (N)	ASTM D 4833	45,000 lb	65 (289)	95 (422)	130 (578)	160 (711)	190 (845)
Carbon Black Content[1], % (Range)	ASTM D 1603*/4218	20,000 lb	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0
Carbon Black Dispersion	ASTM D 5596	45,000 lb	Note[2]	Note[2]	Note[2]	Note[2]	Note[2]
Asperity Height, mil (mm)	ASTM D 7466	second roll	16 (0.40)	18 (0.45)	18 (0.45)	18 (0.45)	18 (0.45)
Notched Constant Tensile Load[3], hr	ASTM D 5397, Appendix	200,000 lb	1,000	1,000	1,000	1,000	1,000
Oxidative Induction Time, min	ASTM D 3895, 200°C; O_2, 1 atm	200,000 lb	>140	>140	>140	>140	>140
TYPICAL ROLL DIMENSIONS							
Roll Length[4], ft (m)	Double-Sided Textured		830 (253)	700 (213)	520 (158)	400 (122)	330 (101)
	Single-Sided Textured		840 (256)	650 (198)	420 (128)	320 (98)	250 (76)
Roll Width[4], ft (m)			22.5 (6.9)	22.5 (6.9)	22.5 (6.9)	22.5 (6.9)	22.5 (6.9)
Roll Area, ft^2 (m^2)	Double-Sided Textured		18,675 (1,735)	15,750 (1,463)	11,700 (1,087)	9,000 (836)	7,425 (690)
	Single-Sided Textured		18,900 (1,755)	14,625 (1,359)	9,450 (878)	7,200 (669)	5,625 (523)

NOTES:

- [1]GSE Green Textured may have an overall ash content greater than 3.0% due to the green layer. These values apply to the black layer only.
- [2]Dispersion only applies to near spherical agglomerates. 9 of 10 views shall be Category 1 or 2. No more than 1 view from Category 3.
- [3]NCTL for Green Textured is conducted on representative smooth membrane samples.
- [4]Roll lengths and widths have a tolerance of ± 1%.
- GSE Green Textured Double-Sided is available in rolls weighing approximately 4,000 lb (1,800 kg) and Single-Sided weighing approximately 3,000 lb (1,360 kg).
- All GSE geomembranes have dimensional stability of ±2% when tested according to ASTM D 1204 and LTB of <-77°C when tested according to ASTM D 746.
- *Modified.

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Appendix D: GSE White Smooth Data Sheet

Product Specifications

These product specifications meet or exceed GRI GM13.

TESTED PROPERTY	TEST METHOD	FREQUENCY	MINIMUM AVERAGE VALUE				
			30 mil	**40 mil**	**60 mil**	**80 mil**	**100 mil**
Thickness, (minimum average) mil (mm) Lowest individual reading (-10%)	ASTM D 5199	every roll	30 (0.75) 27 (0.69)	40 (1.00) 36 (0.91)	60 (1.50) 54 (1.40)	80 (2.00) 72 (1.80)	100 (2.50) 90 (2.30)
Density, g/cm^3	ASTM D 1505	200,000 lb	0.94	0.94	0.94	0.94	0.94
Tensile Properties (each direction) Strength at Break, lb/in-width (N/mm) Strength at Yield, lb/in-width (N/mm) Elongation at Break, % Elongation at Yield, %	ASTM D 6693, Type IV Dumbell, 2 ipm G.L. 2.0 in (51 mm) G.L. 1.3 in (33 mm)	20,000 lb	 120 (21) 66 (11) 700 13	 152 (26) 84 (14) 700 13	 243 (42) 132 (23) 700 13	 327 (57) 177 (30) 700 13	 410 (71) 212 (37) 700 13
Tear Resistance, lb (N)	ASTM D 1004	45,000 lb	21 (93)	28 (124)	42 (186)	58 (257)	73 (324)
Puncture Resistance, lb (N)	ASTM D 4833	45,000 lb	65 (289)	85 (378)	125 (556)	160 (711)	195 (867)
Carbon Black Content[1], % (Range)	ASTM D 1603*/4218	20,000 lb	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0
Carbon Black Dispersion	ASTM D 5596	45,000 lb	Note[2]	Note[2]	Note[2]	Note[2]	Note[2]
Notched Constant Tensile Load, hr	ASTM D 5397, Appendix	200,000 lb	1,000	1,000	1,000	1,000	1,000
Oxidative Induction Time, min	ASTM D 3895, 200°C; O_2, 1 atm	200,000 lb	>140	>140	>140	>140	>140
TYPICAL ROLL DIMENSIONS							
Roll Length[3], ft (m)			1,120 (341)	870 (265)	560 (171)	430 (131)	340 (104)
Roll Width[3], ft (m)			22.5 (6.9)	22.5 (6.9)	22.5 (6.9)	22.5 (6.9)	22.5 (6.9)
Roll Area, ft^2 (m^2)			25,200 (2,341)	19,575 (1,819)	12,600 (1,171)	9,675 (899)	7,650 (711)

NOTES:

- [1]GSE White may have an overall ash content greater than 3.0% due to the white layer. These values apply to the black layer only.
- [2]Dispersion only applies to near spherical agglomerates. 9 of 10 views shall be Category 1 or 2. No more than 1 view from Category 3.
- [3]Roll lengths and widths have a tolerance of ±1%.
- GSE White is available in rolls weighing approximately 3,900 lb (1,769 kg).
- All GSE geomembranes have dimensional stability of ±2% when tested according to ASTM D 1204 and LTB of <-77°C when tested according to ASTM D 746.
- *Modified.

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Appendix D: GSE White Textured Data Sheet

Product Specifications

These product specifications meet or exceed GRI GM13.

TESTED PROPERTY	TEST METHOD	FREQUENCY	MINIMUM AVERAGE VALUE				
			30 mil	40 mil	60 mil	80 mil	100 mil
Thickness, (minimum average) mil (mm) Lowest individual reading (-10%)	ASTM D 5994	every roll	30 (0.75) 27 (0.69)	40 (1.00) 36 (0.91)	60 (1.50) 54 (1.40)	80 (2.00) 72 (1.80)	100 (2.50) 90 (2.30)
Density, g/cm^3	ASTM D 1505	200,000 lb	0.94	0.94	0.94	0.94	0.94
Tensile Properties (each direction) Strength at Break, lb/in-width (N/mm) Strength at Yield, lb/in-width (N/mm) Elongation at Break, % Elongation at Yield, %	ASTM D 6693, Type IV Dumbell, 2 ipm G.L. 2.0 in (51 mm) G.L. 1.3 in (33 mm)	20,000 lb	 66 (11) 68 (11) 100 12	 75 (13) 90 (15) 100 12	 115 (20) 132 (23) 100 12	 155 (27) 177 (31) 100 12	 230 (40) 225 (39) 100 12
Tear Resistance, lb (N)	ASTM D 1004	45,000 lb	24 (106)	32 (142)	45 (200)	60 (266)	75 (333)
Puncture Resistance, lb (N)	ASTM D 4833	45,000 lb	65 (289)	95 (422)	130 (578)	160 (711)	190 (845)
Carbon Black Content[1], % (Range)	ASTM D 1603*/4218	20,000 lb	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0
Carbon Black Dispersion	ASTM D 5596	45,000 lb	Note[2]	Note[2]	Note[2]	Note[2]	Note[2]
Asperity Height, mil (mm)	ASTM D 7466	second roll	16 (0.40)	18 (0.45)	18 (0.45)	18 (0.45)	18 (0.45)
Notched Constant Tensile Load[3], hr	ASTM D 5397, Appendix	200,000 lb	1,000	1,000	1,000	1,000	1,000
Oxidative Induction Time, min	ASTM D 3895, 200°C; O_2, 1 atm	200,000 lb	>140	>140	>140	>140	>140
TYPICAL ROLL DIMENSIONS							
Roll Length[4], ft (m)	Double-Sided Textured Single-Sided Textured		830 (253) 840 (256)	700 (213) 650 (198)	520 (158) 420 (128)	400 (122) 320 (98)	330 (101) 250 (76)
Roll Width[4], ft (m)			22.5 (6.9)	22.5 (6.9)	22.5 (6.9)	22.5 (6.9)	22.5 (6.9)
Roll Area, ft^2 (m^2)	Double-Sided Textured Single-Sided Textured		18,675 (1,735) 18,900 (1,755)	15,750 (1,463) 14,625 (1,359)	11,700 (1,087) 9,450 (878)	9,000 (836) 7,200 (669)	7,425 (690) 5,625 (523)

NOTES:

- [1]GSE White may have an overall ash content greater than 3.0% due to the white layer. These values apply to the black layer only.
- [2]Dispersion only applies to near spherical agglomerates. 9 of 10 views shall be Category 1 or 2. No more than 1 view from Category 3.
- [3]NCTL for GSE White Textured is conducted on representative smooth membrane samples.
- [4]Roll lengths and widths have a tolerance of ± 1%.
- GSE White Textured Double-Sided is available in rolls weighing approximately 4,000 lb (1,800 kg) and Single-Sided weighing approximately 3,000 lb (1,360 kg).
- All GSE geomembranes have dimensional stability of ±2% when tested according to ASTM D 1204 and LTB of <-77°C when tested according to ASTM D 746.
- *Modified.

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Appendix E: GSE Conductive Smooth Data Sheet

Product Specifications

These product specifications meet or exceed GRI GM13.

TESTED PROPERTY	TEST METHOD	FREQUENCY	MINIMUM AVERAGE VALUE			
			40 mil	**60 mil**	**80 mil**	**100 mil**
Thickness, (minimum average) mil (mm) Lowest individual reading (-10%)	ASTM D 5199	every roll	40 (1.00) 36 (0.91)	60 (1.50) 54 (1.40)	80 (2.00) 72 (1.80)	100 (2.50) 90 (2.30)
Density, g/cm^3	ASTM D 1505	200,000 lb	0.94	0.94	0.94	0.94
Tensile Properties (each direction) Strength at Break, lb/in-width (N/mm) Strength at Yield, lb/in-width (N/mm) Elongation at Break, % Elongation at Yield, %	ASTM D 6693, Type IV Dumbell, 2 ipm G.L. 2.0 in (51 mm) G.L. 1.3 in (33 mm)	20,000 lb	 152 (26) 84 (14) 700 13	 243 (42) 132 (23) 700 13	 327 (57) 177 (30) 700 13	 410 (71) 212 (37) 700 13
Tear Resistance, lb (N)	ASTM D 1004	45,000 lb	28 (124)	42 (186)	58 (257)	73 (324)
Puncture Resistance, lb (N)	ASTM D 4833	45,000 lb	85 (378)	125 (556)	160 (711)	195 (867)
Carbon Black Content[(1)], % (Range)	ASTM D 1603*/4218	20,000 lb	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0
Carbon Black Dispersion	ASTM D 5596	45,000 lb	Note[(2)]	Note[(2)]	Note[(2)]	Note[(2)]
Notched Constant Tensile Load, hr	ASTM D 5397, Appendix	200,000 lb	1,000	1,000	1,000	1,000
Oxidative Induction Time, min	ASTM D 3895, 200°C; O_2, 1 atm	200,000 lb	>140	>140	>140	>140
TYPICAL ROLL DIMENSIONS						
Roll Length[(3)], ft (m)			870 (265)	560 (171)	430 (131)	340 (104)
Roll Width[(3)], ft (m)			22.5 (6.9)	22.5 (6.9)	22.5 (6.9)	22.5 (6.9)
Roll Area, ft^2 (m^2)			19,575 (1,819)	12,600 (1,171)	9,675 (899)	7,650 (711)

NOTES:

- [(1)]GSE Conductive may have an overall ash content greater than 3.0%. These values apply to the non-conductive black layers.
- [(2)]Dispersion only applies to near spherical agglomerates. 9 of 10 views shall be Category 1 or 2. No more than 1 view from Category 3.
- [(3)]Roll lengths and widths have a tolerance of ± 1%.
- GSE Conductive is available in rolls weighing approximately 3,900 lb (1,769 kg).
- All GSE geomembranes have dimensional stability of ±2% when tested according to ASTM D 1204 and LTB of <-77°C when tested according to ASTM D 746.
- *Modified.

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Appendix E: GSE Conductive Textured (Single-Sided) Data Sheet

Product Specifications

These product specifications meet or exceed GRI GM13.

TESTED PROPERTY	TEST METHOD	FREQUENCY	MINIMUM AVERAGE VALUE			
			40 mil	60 mil	80 mil	100 mil
Thickness, (minimum average) mil (mm) Lowest individual reading (-10%)	ASTM D 5994	every roll	40 (1.00) 36 (0.91)	60 (1.50) 54 (1.40)	80 (2.00) 72 (1.80)	100 (2.50) 90 (2.30)
Density, g/cm^3	ASTM D 1505	200,000 lb	0.94	0.94	0.94	0.94
Tensile Properties (each direction) Strength at Break, lb/in-width (N/mm) Strength at Yield, lb/in-width (N/mm) Elongation at Break, % Elongation at Yield, %	ASTM D 6693, Type IV Dumbell, 2 ipm G.L. 2.0 in (51 mm) G.L. 1.3 in (33 mm)	20,000 lb	 75 (13) 90 (15) 100 12	 115 (20) 132 (23) 100 12	 155 (27) 177 (31) 100 12	 230 (40) 225 (39) 100 12
Tear Resistance, lb (N)	ASTM D 1004	45,000 lb	32 (142)	45 (200)	60 (266)	75 (333)
Puncture Resistance, lb (N)	ASTM D 4833	45,000 lb	95 (422)	130 (578)	160 (711)	190 (845)
Carbon Black Content[1], % (Range)	ASTM D 1603*/4218	20,000 lb	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0
Carbon Black Dispersion	ASTM D 5596	45,000 lb	Note[2]	Note[2]	Note[2]	Note[2]
Asperity Height, mil (mm)	ASTM D 7466	second roll	18 (0.45)	18 (0.45)	18 (0.45)	18 (0.45)
Notched Constant Tensile Load[3], hr	ASTM D 5397, Appendix	200,000 lb	1,000	1,000	1,000	1,000
Oxidative Induction Time, min	ASTM D 3895, 200°C; O_2, 1 atm	200,000 lb	>140	>140	>140	>140
TYPICAL ROLL DIMENSIONS						
Roll Length[4], ft (m)			650 (198)	420 (128)	320 (98)	250 (76)
Roll Width[4], ft (m)			22.5 (6.9)	22.5 (6.9)	22.5 (6.9)	22.5 (6.9)
Roll Area, ft^2, (m^2), ft			14,625 (1,359)	9,450 (878)	7,200 (669)	5,625 (523)

NOTES:

- [1]GSE Conductive Textured may have an overall ash content greater than 3.0%. These values apply to the non-conductive black layers.
- [2]Dispersion only applies to near spherical agglomerates. 9 of 10 views shall be Category 1 or 2. No more than 1 view from Category 3.
- [3]NCTL for GSE Conductive Textured is conducted on representative smooth membrane samples.
- [4]Roll lengths and widths have a tolerance of ± 1%.
- GSE Conductive Textured Single-Sided is available in rolls weighing approximately 3,000 lb (1,360 kg).
- All GSE geomembranes have dimensional stability of ±2% when tested according to ASTM D 1204 and LTB of <-77°C when tested according to ASTM D 746.
- *Modified.

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Appendix F: GSE Conductive White Smooth Data Sheet

Product Specifications

These product specifications meet or exceed GRI GM13.

TESTED PROPERTY	TEST METHOD	FREQUENCY	MINIMUM AVERAGE VALUE			
			40 mil	**60 mil**	**80 mil**	**100 mil**
Thickness, (minimum average) mil (mm) Lowest individual reading (-10%)	ASTM D 5199	every roll	40 (1.00) 36 (0.91)	60 (1.50) 54 (1.40)	80 (2.00) 72 (1.80)	100 (2.50) 90 (2.30)
Density, g/cm^3	ASTM D 1505	200,000 lb	0.94	0.94	0.94	0.94
Tensile Properties (each direction) Strength at Break, lb/in-width (N/mm) Strength at Yield, lb/in-width (N/mm) Elongation at Break, % Elongation at Yield, %	ASTM D 6693, Type IV Dumbell, 2 ipm G.L. 2.0 in (51 mm) G.L. 1.3 in (33 mm)	20,000 lb	 152 (26) 84 (14) 700 13	 243 (42) 132 (23) 700 13	 327 (57) 177 (30) 700 13	 410 (71) 212 (37) 700 13
Tear Resistance, lb (N)	ASTM D 1004	45,000 lb	28 (124)	42 (186)	58 (257)	73 (324)
Puncture Resistance, lb (N)	ASTM D 4833	45,000 lb	85 (378)	125 (556)	160 (711)	195 (867)
Carbon Black Content[1], % (Range)	ASTM D 1603*/4218	20,000 lb	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0
Carbon Black Dispersion	ASTM D 5596	45,000 lb	Note[2]	Note[2]	Note[2]	Note[2]
Notched Constant Tensile Load, hr	ASTM D 5397, Appendix	200,000 lb	1,000	1,000	1,000	1,000
Oxidative Induction Time, min	ASTM D 3895, 200°C; O_2, 1 atm	200,000 lb	>140	>140	>140	>140
TYPICAL ROLL DIMENSIONS						
Roll Length[3], ft (m)			870 (265)	560 (171)	430 (131)	340 (104)
Roll Width[3], ft (m)			22.5 (6.9)	22.5 (6.9)	22.5 (6.9)	22.5 (6.9)
Roll Area, ft^2 (m^2)			19,575 (1,819)	12,600 (1,171)	9,675 (899)	7,650 (711)

NOTES:

- [1]GSE Conductive White may have an overall ash content greater than 3.0% due to the white and conductive outer layers. These values apply to the non-conductive black layers.
- [2]Dispersion only applies to near spherical agglomerates. 9 of 10 views shall be Category 1 or 2. No more than 1 view from Category 3.
- [3]Roll lengths and widths have a tolerance of ± 1%.
- GSE Conductive White is available in rolls weighing approximately 3,900 lb (1,769 kg).
- All GSE geomembranes have dimensional stability of ±2% when tested according to ASTM D 1204 and LTB of <-77°C when tested according to ASTM D 746.
- *Modified.

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Appendix F: GSE Conductive White Textured (Single-Sided) Data Sheet

Product Specifications

These product specifications meet or exceed GRI GM13.

TESTED PROPERTY	TEST METHOD	FREQUENCY	MINIMUM AVERAGE VALUE			
			40 mil	60 mil	80 mil	100 mil
Thickness, (minimum average) mil (mm) Lowest individual reading (-10%)	ASTM D 5994	every roll	40 (1.00) 36 (0.91)	60 (1.50) 54 (1.40)	80 (2.00) 72 (1.80)	100 (2.50) 90 (2.30)
Density, g/cm^3	ASTM D 1505	200,000 lb	0.94	0.94	0.94	0.94
Tensile Properties (each direction)	ASTM D 6693, Type IV	20,000 lb				
Strength at Break, lb/in-width (N/mm)	Dumbell, 2 ipm		75 (13)	115 (20)	155 (27)	230 (40)
Strength at Yield, lb/in-width (N/mm)			90 (15)	132 (23)	177 (31)	225 (39)
Elongation at Break, %	G.L. 2.0 in (51 mm)		100	100	100	100
Elongation at Yield, %	G.L. 1.3 in (33 mm)		12	12	12	12
Tear Resistance, lb (N)	ASTM D 1004	45,000 lb	32 (142)	45 (200)	60 (266)	75 (333)
Puncture Resistance, lb (N)	ASTM D 4833	45,000 lb	95 (422)	130 (578)	160 (711)	190 (845)
Carbon Black Content[1], % (Range)	ASTM D 1603*/4218	20,000 lb	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0
Carbon Black Dispersion	ASTM D 5596	45,000 lb	Note[2]	Note[2]	Note[2]	Note[2]
Asperity Height, mil (mm)	ASTM D 7466	second roll	18 (0.45)	18 (0.45)	18 (0.45)	18 (0.45)
Notched Constant Tensile Load[3], hr	ASTM D 5397, Appendix	200,000 lb	1,000	1,000	1,000	1,000
Oxidative Induction Time, min	ASTM D 3895, 200°C; O_2, 1 atm	200,000 lb	>140	>140	>140	>140
TYPICAL ROLL DIMENSIONS						
Roll Length[4], ft (m)			650 (198)	420 (128)	320 (98)	250 (76)
Roll Width[4], ft (m)			22.5 (6.9)	22.5 (6.9)	22.5 (6.9)	22.5 (6.9)
Roll Area, ft^2, (m^2), ft			14,625 (1,359)	9,450 (878)	7,200 (669)	5,625 (523)

NOTES:

- [1]GSE Conductive White Textured may have an overall ash content greater than 3.0% due to the white and conductive outer layers. These values apply to the non-conductive black layers.
- [2]Dispersion only applies to near spherical agglomerates. 9 of 10 views shall be Category 1 or 2. No more than 1 view from Category 3.
- [3]NCTL for GSE Conductive White Textured is conducted on representative smooth membrane samples.
- [4]Roll lengths and widths have a tolerance of ± 1%.
- GSE Conductive White Textured Single-Sided is available in rolls weighing approximately 3,000 lb (1,360 kg).
- All GSE geomembranes have dimensional stability of ±2% when tested according to ASTM D 1204 and LTB of <-77°C when tested according to ASTM D 746.
- *Modified.

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Appendix G: GSE UltraFlex Smooth Data Sheet

Product Specifications

These product specifications meet or exceed GRI GM17.

TESTED PROPERTY	TEST METHOD	FREQUENCY	MINIMUM AVERAGE VALUE			
			40 mil	60 mil	80 mil	100 mil
Thickness, (minimum average) mil (mm) Lowest individual reading (-10%)	ASTM D 5199	every roll	40 (1.00) 36 (0.91)	60 (1.50) 54 (1.40)	80 (2.00) 72 (1.80)	100 (2.50) 90 (2.28)
Density, g/cm^3	ASTM D 1505	200,000 lb	0.92	0.92	0.92	0.92
Tensile Properties (each direction) Strength at Break, lb/in-width (N/mm) Elongation at Break, %	ASTM D 6693, Type IV Dumbell, 2 ipm G.L. 2.0 in (51 mm)	20,000 lb	 170 (29) 800	 240 (42) 800	 320 (56) 800	 380 (66) 800
Tear Resistance, lb (N)	ASTM D 1004	45,000 lb	22 (97)	33 (146)	44 (195)	55 (244)
Puncture Resistance, lb (N)	ASTM D 4833	45,000 lb	70 (311)	100 (444)	130 (578)	155 (689)
Carbon Black Content, % (Range)	ASTM D 1603*/4218	20,000 lb	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0
Carbon Black Dispersion	ASTM D 5596	45,000 lb	Note(1)	Note(1)	Note(1)	Note(1)
Oxidative Induction Time, min	ASTM D 3895, 200° C; O_2, 1 atm	200,000 lb	>140	>140	>140	>140
TYPICAL ROLL DIMENSIONS						
Roll Length(2), ft (m)			870 (265)	560 (171)	430 (131)	340 (103)
Roll Width(2), ft (m)			22.5 (6.9)	22.5 (6.9)	22.5 (6.9)	22.5 (6.9)
Roll Area, ft^2 (m^2)			19,575 (1,819)	12,600 (1,171)	9,675 (899)	7,650 (710)

NOTES:

- (1)Dispersion only applies to near spherical agglomerates. 9 of 10 views shall be Category 1 or 2. No more than 1 view from Category 3.
- (2)Roll lengths and widths have a tolerance of ±1%.
- GSE UltraFlex is available in rolls weighing approximately 3,900 lb (1,769 kg).
- All GSE geomembranes have dimensional stability of ±2% when tested according to ASTM D 1204 and LTB of <-77°C when tested according to ASTM D 746.
- *Modified.

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Appendix G: GSE UltraFlex Textured Data Sheet

Product Specifications

These product specifications meet or exceed GRI GM17.

TESTED PROPERTY	TEST METHOD	FREQUENCY	MINIMUM AVERAGE VALUE			
			40 mil	**60 mil**	**80 mil**	**100 mil**
Thickness, (minimum average) mil (mm) Lowest individual reading (-10%)	ASTM D 5994	every roll	40 (1.00) 36 (0.91)	60 (1.50) 54 (1.40)	80 (2.00) 72 (1.80)	100 (2.50) 90 (2.28)
Density, g/cm^3	ASTM D 1505	200,000 lb	0.92	0.92	0.92	0.92
Tensile Properties (each direction) Strength at Break, lb/in-width (N/mm) Elongation at Break, %	ASTM D 6693, Type IV Dumbell, 2 ipm G.L. 2.0 in (51 mm)	20,000 lb	 115 (20) 500	 168 (29) 500	 224 (39) 500	 270 (47) 500
Tear Resistance, lb (N)	ASTM D 1004	45,000 lb	25 (111)	38 (169)	50 (222)	60 (266)
Puncture Resistance, lb (N)	ASTM D 4833	45,000 lb	65 (289)	95 (422)	125 (556)	140 (622)
Carbon Black Content, % (Range)	ASTM D 1603*/4218	20,000 lb	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0
Carbon Black Dispersion	ASTM D 5596	45,000 lb	Note(1)	Note(1)	Note(1)	Note(1)
Asperity Height, mil (mm)	ASTM D 7466	second roll	18 (0.45)	18 (0.45)	18 (0.45)	18 (0.45)
Oxidative Induction Time, min	ASTM D 3895, 200° C; O_2, 1 atm	200,000 lb	>140	>140	>140	>140
TYPICAL ROLL DIMENSIONS						
Roll Length(2), ft (m)	Double-Sided Textured Single-Sided Textured		700 (213) 650 (198)	520 (158) 420 (128)	400 (122) 320 (98)	330 (100) 250 (76)
Roll Width(2), ft (m)			22.5 (6.9)	22.5 (6.9)	22.5 (6.9)	22.5 (6.9)
Roll Area, ft^2 (m^2)	Double-Sided Textured Single-Sided Textured		15,750 (1,463) 14,625 (1,359)	11,700 (1,087) 9,450 (878)	9,000 (836) 7,200 (669)	7,425 (689) 5,625 (522)

NOTES:

- (1)Dispersion only applies to near spherical agglomerates. 9 of 10 views shall be Category 1 or 2. No more than 1 view from Category 3.
- (2)Roll lengths and widths have a tolerance of ±1%.
- GSE UltraFlex Textured Double-Sided is available in rolls weighing approximately 4,000 lb (1,800 kg) and Single-Sided weighing approximately 3,000 lb (1,360 kg).
- All GSE geomembranes have dimensional stability of ±2% when tested according to ASTM D 1204 and LTB of <-77°C when tested according to ASTM D 746.
- *Modified.

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Appendix H: GSE UltraFlex White Smooth Data Sheet

Product Specifications

These product specifications meet or exceed GRI GM17.

TESTED PROPERTY	TEST METHOD	FREQUENCY	MINIMUM AVERAGE VALUE			
			40 mil	**60 mil**	**80 mil**	**100 mil**
Thickness, (minimum average) mil (mm) Lowest individual reading (-10%)	ASTM D 5199	every roll	40 (1.00) 36 (0.91)	60 (1.50) 54 (1.40)	80 (2.00) 72 (1.80)	100 (2.50) 90 (2.28)
Density, g/cm^3	ASTM D 1505	200,000 lb	0.92	0.92	0.92	0.92
Tensile Properties (each direction) Strength at Break, lb/in-width (N/mm) Elongation at Break, %	ASTM D 6693, Type IV Dumbell, 2 ipm G.L. 2.0 in (51 mm)	20,000 lb	 170 (29) 800	 240 (42) 800	 320 (56) 800	 380 (66) 800
Tear Resistance, lb (N)	ASTM D 1004	45,000 lb	22 (97)	33 (146)	44 (195)	55 (244)
Puncture Resistance, lb (N)	ASTM D 4833	45,000 lb	70 (311)	100 (444)	130 (578)	155 (689)
Carbon Black Content[1], % (Range)	ASTM D 1603*/4218	20,000 lb	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0
Carbon Black Dispersion	ASTM D 5596	45,000 lb	Note[2]	Note[2]	Note[2]	Note[2]
Oxidative Induction Time, min	ASTM D 3895, 200° C; O_2, 1 atm	200,000 lb	>140	>140	>140	>140
TYPICAL ROLL DIMENSIONS						
Roll Length[3], ft (m)			870 (265)	560 (171)	430 (131)	340 (103)
Roll Width[3], ft (m)			22.5 (6.9)	22.5 (6.9)	22.5 (6.9)	22.5 (6.9)
Roll Area, ft^2 (m^2)			19,575 (1,819)	12,600 (1,171)	9,675 (899)	7,650 (710)

NOTES:

- [1]GSE UltraFlex White may have an overall ash content greater than 3.0% due to the white layer. These values apply to the black layer only.
- [2]Dispersion only applies to near spherical agglomerates. 9 of 10 views shall be Category 1 or 2. No more than 1 view from Category 3.
- [3]Roll lengths and widths have a tolerance of ±1%.
- GSE UltraFlex White is available in rolls weighing approximately 3,900 lb (1,769 kg).
- All GSE geomembranes have dimensional stability of ±2% when tested according to ASTM D 1204 and LTB of <-77°C when tested according to ASTM D 746.
- *Modified.

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Appendix H: GSE UltraFlex White Textured Data Sheet

Product Specifications

These product specifications meet or exceed GRI GM17.

TESTED PROPERTY	TEST METHOD	FREQUENCY	MINIMUM AVERAGE VALUE			
			40 mil	**60 mil**	**80 mil**	**100 mil**
Thickness, (minimum average) mil (mm) Lowest individual reading (-10%)	ASTM D 5994	every roll	40 (1.00) 36 (0.91)	60 (1.50) 54 (1.40)	80 (2.00) 72 (1.80)	100 (2.50) 90 (2.28)
Density, g/cm^3	ASTM D 1505	200,000 lb	0.92	0.92	0.92	0.92
Tensile Properties (each direction) Strength at Break, lb/in-width (N/mm) Elongation at Break, %	ASTM D 6693, Type IV Dumbell, 2 ipm G.L. 2.0 in (51 mm)	20,000 lb	 115 (20) 500	 168 (29) 500	 224 (39) 500	 270 (47) 500
Tear Resistance, lb (N)	ASTM D 1004	45,000 lb	25 (111)	38 (169)	50 (222)	60 (266)
Puncture Resistance, lb (N)	ASTM D 4833	45,000 lb	65 (289)	95 (422)	125 (556)	140 (622)
Carbon Black Content(1), % (Range)	ASTM D 1603*/4218	20,000 lb	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0
Carbon Black Dispersion	ASTM D 5596	45,000 lb	Note(2)	Note(2)	Note(2)	Note(2)
Asperity Height, mil (mm)	ASTM D 7466	second roll	18 (0.45)	18 (0.45)	18 (0.45)	18 (0.45)
Oxidative Induction Time, min	ASTM D 3895, 200° C; O_2, 1 atm	200,000 lb	>140	>140	>140	>140
TYPICAL ROLL DIMENSIONS						
Roll Length(3), ft (m)	Double-Sided Textured Single-Sided Textured		700 (213) 650 (198)	520 (158) 420 (128)	400 (122) 320 (98)	330 (100) 250 (76)
Roll Width(3), ft (m)			22.5 (6.9)	22.5 (6.9)	22.5 (6.9)	22.5 (6.9)
Roll Area, ft^2 (m^2)	Double-Sided Textured Single-Sided Textured		15,750 (1,463) 14,625 (1,359)	11,700 (1,087) 9,450 (878)	9,000 (836) 7,200 (669)	7,425 (689) 5,625 (522)

NOTES:

- (1)GSE UltraFlex White Textured may have an overall ash content greater than 3.0% due to the white layer. These values apply to the black layer only.
- (2)Dispersion only applies to near spherical agglomerates. 9 of 10 views shall be Category 1 or 2. No more than 1 view from Category 3.
- (3)Roll lengths and widths have a tolerance of ±1%.
- GSE UltraFlex White Textured Double-Sided is available in rolls weighing approximately 4,000 lb (1,800 kg) and Single-Sided weighing approximately 3,000 lb (1,360 kg).
- All GSE geomembranes have dimensional stability of ±2% when tested according to ASTM D 1204 and LTB of <-77°C when tested according to ASTM D 746.
- *Modified.

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