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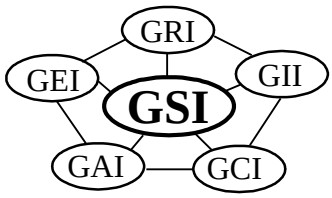

Original: October 13, 2017

GRI Standard GM19b*

Standard Specification for

Seam Strength and Related Properties of Thermally Bonded Reinforced Polyolefin Geomembranes/Barriers

This specification was developed by the Geosynthetic Research Institute (GRI), with the cooperation of the member organizations for general use by the public. It is completely optional in this regard and can be superseded by other existing or new specifications on the subject matter in whole or in part. Neither GRI, the Geosynthetic Institute, nor any of its related institutes, warrant or indemnifies any materials produced according to this specification either at this time or in the future.

1. Scope

1.1 This specification addresses the required seam strength and related properties of thermally bonded reinforced polyolefin geomembranes and barriers. Included herein are the following.

- reinforced linear low density polyethylene (LLDPE-R)
- reinforced polyethylene (PE-R)
- coated polyethylene (cPE)
- reinforced flexible polypropylene (fPP-R)
- reinforced chlorosulfonated polyethylene (CSPE-R)

Note 1: The existing GRI sheet specifications for the above are available at www.geosynthetic-institute.org/specs.htm.

Note 2: Also see the complimentary GRI Seam Specification GM19a for homogenous (or nonreinforced) geomembrane seams made from high density polyethylene (HDPE), linear low density polyethylene (LLDPE) and flexible polypropylene (fPP).

*This GRI standard is developed by the Geosynthetic Research Institute through consultation and review by the member organizations. This specification will be reviewed at least every 5-years, or on an as-required basis. In this regard it is subject to change at any time. The most recent revision date is the effective version.

Note 3: The distinction between geomembranes and barriers is very subjective at present. One possible distinction is based on thickness since the U.S. EPA requires a minimum thickness of 30 mils (0.75 mm) for waste containment in its RCRA regulations. Barriers would then consist of thicknesses less than 30 mils (0.75 mm).

Note 4: The reinforcement component of geomembranes and barriers is usually polymeric textiles in various forms. Woven multifilament yarns and woven monofilaments of various percent open areas are relatively common. Such fabric reinforcement is also referred to as "scrim" reinforcement.

1.2 Numeric values of seam strength and related properties are specified herein in both shear and peel modes.

Note 5: This specification does not address the test method details or specific testing procedures. It refers to the relevant ASTM test method in this regard, i.e., ASTM D7747.

1.3 The thermal bonding methods focused upon in this standard are hot wedge (single and dual track) and hot air. Other acceptable, but less frequently used, methods of seaming are extrusion fillet, ultrasonic and sewing methods.

1.4 This specification does not suggest a specific distance between destructive seam samples to be taken in the field, i.e., the sampling interval. Two separate GRI Standard Practices are focused on this issue, see GRI-GM14 and GRI-GM20.

1.5 This specification is only applicable to the laboratory testing of geomembrane/barrier seams.

Note 6: Field trial seams, or test strip seams, can also utilize this specification but acceptance depends on the construction quality assurance plan and/or parties involved.

1.6 This specification does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

2. Referenced Documents

2.1 ASTM Standards

D76 Standard Specification for Tensile Testing Machines for Textiles

D6392 Standard Test Method for Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using Thermo-Fusion Methods
D7747 Standard Test Method for Determining Integrity of Seams Produced Using Thermo-Fusion Methods for Reinforced Geomembranes by the Strip Tensile Method
E4 Standard Practice for Force Verification of Testing Machines

2.2 EPA Standards

EPA 600/2.88/052 (NTIS PB-89-129670)
Lining of Waste Containment and Other Containment Facilities

2.3 GRI Standards

GB22 Test Methods, Required Properties, and Testing Frequencies for Scrim Reinforced Polytheylene (PE-R) Barriers Used in Exposed Temporary Applications
GB30 Test Method, Required Properties and Testing Frequencies for Coated Tape Polyethylene (cPE) Barriers
GM14 Guide for Selecting Variable Intervals for Taking Geomembrane Destructive Seam Samples Using the Method of Attributes
GM18 Test Properties and Testing Frequency for Flexible Polypropylene (fPP and fPP-R) Geomembranes
GM20 Guide for Selecting Variable Intervals for Taking Geomembrane Destructive Seam Samples Using Control Charts
GM25 Test Property and Testing Frequency for Scrim Reinforced Linear Low Density Polyethylene (LLDPE-R) Geomembranes
GM28 Test Method, Test Properties and Testing Frequencies for Reinforced Chlorosulfonated Polyethylene (CSPE-R) Geomembranes

3. Definitions

3.1 Geomembrane, n – An essentially impermeable geosynthetic composed of one or more synthetic sheets used for the purpose of liquid, gas or solid containment.

Note 7: This specification addresses seams of reinforced geomembranes and barriers. GRI-GM19a addresses homogeneous (or nonreinforced) geomembranes.

3.2 Hot Wedge Seaming – A thermal technique which melts the two opposing geomembrane surfaces to be seamed by running a hot metal wedge or knife between them. Pressure is applied to the top or bottom geomembrane, or both, to form a continuous bond. Seams of this type can be made with dual bond tracks separated by a nonbonded gap. These seams are referred to as dual hot wedge seams or double-track seams.

3.3 Hot Air Seaming – This seaming technique introduces high-temperature air or gas between two geomembrane surfaces to facilitate localized surface melting. Pressure is applied to the top or bottom geomembrane, forcing together the two surfaces to form a continuous bond.

3.4 Ultrasonic Seaming - A thermal technique which melts the two opposing geomembrane surfaces to be seamed by running a ultrasonically vibrated metal wedge or knife between them. Pressure is applied to the top or bottom geomembrane, or both, to form a continuous bond. Some seams of this type are made with dual bond tracks separated by a nonbonded gap. These seams are referred to as dual-track seams or double-track seams.

3.5 Extrusion Fillet Seaming – This seaming technique involves extruding molten resin at the edge of overlapped geomembranes to form a continuous bond. A depreciated method called "extrusion flat" seaming extrudes the molten resin between the two overlapped sheets. In all types of extrusion seaming the surfaces upon which the molten resin is applied must be suitably roughened, usually by a slight grinding or buffing.

3.6 Sewn Seams - Some very thin reinforced barriers can be made by sewing. Depending upon conditions and the parties involved this can be acceptable.

3.7 U.S. EPA (1991) - Resource Conservation and Recovery Act (RCRA), Title 40, Code of Federal Regulations (CFR), Part 261 (40 CFR 261), Subpart D and Subpart C.

4. Significance and Use

4.1 The various test methods of seamed polyolefin geomembrane/barriers in shear and peel are covered in existing ASTM standards mentioned in the referenced document section. For example, D6392 is for nonreinforced and D7747 is for reinforced seams. What is not covered in those documents are the numeric values of shear and peel strength and related properties that the completed seam must meet, or exceed. *This specification provides this information insofar as minimum test values are concerned after the field fabricated seams are sampled and laboratory tested in shear and peel.* Such results must meet or exceed the values given in the attached tables for the respective types of geomembranes/barriers.

5. Apparatus

5.1 Tensile Testing Machine - A constant rate of extension (CRE) device meeting the requirements of ASTM Specification D76. The load cell shall be accurate to within ± 1% of the applied force and verified per ASTM E4. The drive mechanism shall be able to control the rate of extension to within ± 1% of the targeted rate. The maximum allowable error in recorded grip displacement shall be ± 1% of the recorded values. The maximum allowable variation in nominal gage length on repeated return of the grips to their starting position shall be less than 0.01 in. (0.25 mm).

5.2 Grip Faces - The clamping mechanism and clamp surfaces shall hold the specimen firmly without causing damage.

5.2.1 Clamp faces shall be a minimum of 1.0 in. (25 mm) in the dimension parallel to direction of test and wide enough to grip full width of the specimen.

Note 8: Test specimens failing at the grip faces or within the grips shall be discarded, i.e., failure must be within the test specimen's gage length.

6. Sample and Specimen Preparation

6.1 The spacings for taking field seam samples for destructive testing can be a fixed or variable interval, or can be statistically related as provided in GRI-GM14 and GRI-GM20. These statistical processes describe a progression from the most restrictive interval of 1 per 500 feet (1 per 150 m) to the complete use and reliance of the electrical leak location survey (ELLS) method. Intermediate between these extremes are variations depending upon the inspectors requirements and the installers experience and performance.

Note 9: The project-specific sampling spacing is decided upon by the design engineer or CQA organization.

6.2 The size of field seam samples is to be according to the referenced test method, e.g., ASTM D7747 or site-specific CQA plan.

6.3 The individual test specimens taken from the field seam samples are to be tested according to ASTM D7747. The specimens are to be conditioned prior to testing according to this same test method and evaluated accordingly.

7. Assessment of Seam Test Results

The tables to follow for the five specific types of geomembranes or barriers under consideration all use ASTM D7747 as the test protocol. As such, the seam test specimens are 1.0 in. (25 mm) in width with the seamed area central to the opposing grip faces. The orientation of the specimens should be indicated accordingly. For each seam sample there will be five replicate tests conducted in shear and an adjacent five replicate tests conducted in peel. All ten test specimens must meet or exceed the values given in the respective tables to follow.

7.1 Linear low density polyethylene reinforced (LLDPE-R) seams - For LLDPE-R seams (following the LLDPE sheet material specification of GRI-GM25) the strength of all five-out-of-five strip tensile shear tests and five-out-of-five peel tests should meet or exceed the values given in Tables 1(a) or 1(b). See ASTM D7747 for procedures in conducting the shear and peel tests. Regarding location of break (LOB) codes, AD1, AD2 and AD-WLD are not allowed whereas SIP-R, SIP-CI and SIPCO are allowed provided that the respective strength values are achieved.

7.2 Polyethylene reinforced (PE-R) barrier seams - For PE-R seams (following the PE-R sheet material specification of GRI-GB22) the strength of all five-out-of-five strip tensile shear tests and five-out-of-five peel tests should meet or exceed the values given in Tables 2(a) or 2(b). See ASTM D7747 for procedures in conducting the shear and peel tests. Regarding location of break (LOB) codes, they do not apply due to orientation of the scrim reinforcement yarns.

7.3 Coated polyethylene barrier (cPE) seams - For cPE barrier seams (following the cPE sheet material specification of GRI-GB30) the strength of all five-out-of-five strip tensile shear tests and five-out-of-five peel tests should meet or exceed the values given in Tables 3(a) or 3(b). See ASTM D7747 for procedures in conducting the shear and peel tests. Regarding location of break (LOB) codes, AD1, AD2 and AD-WLD are not allowed whereas SIP-R, SIP-CI and SIPCO are allowed provided that the respective strength values are achieved.

7.4 Flexible polypropylene reinforced (fPP-R) seams - For fPP-R seams (following the fPP sheet material specification for GRI-GM18) the strength of all five-out-of-five strip tensile shear tests and five-out-of-five peel tests should meet or exceed the values given in Tables 4(a) or 4(b). See ASTM D7747 for procedures in conducting the shear and peel tests. Regarding location of break (LOB) codes, AD1, AD2 and AD-WLD are not allowed whereas SIP-R, SIP-CI and SIPCO are allowed provided that the respective strength values are achieved.

7.5 Chlorosulphonated polyethylene reinforced (CSPE-R) seams - For CSPE-R seams (following the CSPE sheet material specification of GRI-GM28 the strength of all five-out-of-five strip tensile shear tests and five-out-of-five peel tests should meet or exceed the values given in Tables 5(a) or 5(b). See ASTM D7747 for procedures in conducting the shear and peel tests. Regarding location of break (LOB) codes, AD1, AD2 and AD-WLD are not allowed whereas SIP-R, SIP-CI and SIPCO are allowed provided that the respective strength values are achieved.

Note 10: The conversion from the original U.S. Standard Units to SI (Metric) Units is “soft”.

U.S. Standard Units

Table 1(a) – Seam Strength of Thermally Bonded Reinforced Linear Low Density Polyethylene (LLDPE-R) Geomembranes Made According to GRI-GM25(2)

Property	Test Method	Min. Value	Min. Value
Sheet Thickness • nominal (mils)	D5199 (Method A)	 36	 45
Hot Wedge/Air Seams(1) • shear strength, lb • peel strength, lb	D7747	 75 30	 90 30
Other Seam Types • shear strength, lb • peel strength, lb	D7747	 80 30	 100 30

(1) Also for other possible seaming methods, e.g., ultrasonic
(2) Values are based on 1.0 in. (25 mm) wide strip tensile strength per D7747 for laboratory tested specimens

SI (Metric) Units

Table 1(b) – Seam Strength of Thermally Bonded Reinforced Linear Low Density Polyethylene (LLDPE-R) Geomembranes Made According to GRI-GM25(2)

Property	Test Method	Min. Value	Min. Value
Sheet Thickness • nominal (mm)	D5199 (Method A)	 0.91	 1.14
Hot Wedge/Air Seams(1) • shear strength, N • peel strength, N	D7747	 330 130	 400 130
Other Seam Types • shear strength, N • peel strength, N	D7747	 350 130	 440 130

(1) Also for other possible seaming, e.g., ultrasonic
(2) Values are based on 25 mm (1.0 in.) wide strip tensile strength per D7747 for laboratory tested specimens

U.S. Standard Units

Table 2(a) - Seam Strength of Thermally Bonded Polyethylene Reinforced (PE-R) Barrier Seams Made According to GRI-GB22[2]

Property	Test Method	Min. Value	Min. Value	Min. Value
Sheet Thickness • nominal (mils)	D5199	 8.0	 12.0	 20.0
Hot Wedge/Air Seams[1] • shear strength (lb) • peel strength (lb)	D7747	 12 6	 18 7	 24 9

(1) Also for other possible seaming methods, e.g., ultrasonic
(2) Values are based on 1.0 in. (25 mm) wide strip tensile strength per D7747 for laboratory tested specimens

SI (Metric) Units

Table 2(b) - Seam Strength of Thermally Bonded Polyethylene Reinforced (PE-R) Barrier Seams Made According to GRI-GB22[2]

Property	Test Method	Min. Value	Min. Value	Min. Value
Sheet Thickness • nominal (mm)	D5199 (Method A)	 0.20	 0.30	 0.50
Hot Wedge/Air Seams[1] • shear strength (N) • peel strength (N)	D7747	 53 53	 80 66	 106 80

(1) Also for other possible seaming methods, e.g., ultrasonic
(2) Values are based on 25 mm (1.0 in.) wide strip tensile strength per D7747 for laboratory tested specimens

U.S. Standard Units

Table 3(a) - Seam Strength of Thermally Bonded Coated Polyethylene (cPE) Reinforced Barrier Seams Made According to GRI-GB30(2)

Property	Test Method	Min. Value	Min. Value	Min. Value
Sheet Thickness • nominal (mils)	D5199 (Method A)	 24	 30	 40
Hot Wedge/Air Seams(1) • shear strength (lb) • peel strength (lb)	D7747	 30 10	 60 10	 90 10
Other Seam Types • shear strength (lb) • peel strength (lb)	D7747	 30 10	 60 10	 90 10

(1) Also for other possible seaming methods, e.g., ultrasonic
(2) Values are based on 1.0 in. (25 mm) wide strip tensile strength per D7747 for laboratory tested specimens

SI (Metric) Units

Table 3(b) - Seam Strength of Thermally Bonded Coated Polyethylene (cPE) Reinforced Barrier Seams Made According to GRI-GB30(2)

Property	Test Method	Min. Value	Min. Value	Min. Value
Sheet Thickness • nominal (mm)	D5199 (Method A)	 0.61	 0.76	 1.02
Hot Wedge/Air Seams(1) • shear strength (N) • peel strength (N)	D7747	 130 45	 270 45	 400 45
Other Seam Types • shear strength (N) • peel strength (N)	D7747	 130 45	 270 45	 400 45

(1) Also for other possible seaming methods, e.g., ultrasonic
(2) Values are based on 25 mm (1.0 in.) wide strip tensile strength per D7747 for laboratory tested specimens

U.S. Standard Units

Table 4(a) – Seam Strength of Thermally Bonded Reinforced Flexible Polypropylene (fPP-R) Geomembranes Made According to GRI-GM18(2)

Property	Test Method	Min. Value	Min. Value	Min. Value
Sheet Thickness • nominal (mils)	D5199 (Method A)	 36	 45	 60
Hot Wedge/Air Seams(1) • shear strength (lb) • peel strength (lb)	D7747	 50 25	 60 25	 70 25
Other Seam Types • shear strength (lb) • peel strength (lb)	D7747	 50 25	 60 25	 70 25

(1) Also for other possible seaming methods, e.g., ultrasonic
(2) Values are based on 1.0 in. (25 mm) wide strip tensile strength per D7747 for laboratory tested specimens

SI (Metric) Units

Table 4(b) – Seam Strength of Thermally Bonded Reinforced Flexible Polypropylene (fPP-R) Geomembranes Made According to GRI-GM18(2)

Property	Test Method	Min. Value	Min. Value	Min. Value
Sheet Thickness • nominal (mm)	D5199 (Method A)	 0.91	 1.14	 1.52
Hot Wedge/Air Seams(1) • shear strength (N) • peel strength (N)	D7747	 220 110	 270 110	 310 110
Other Seam Types • shear strength (N) • peel strength (N)	D7747	 220 110	 270 110	 310 110

(1) Also for other possible seaming methods, e.g., ultrasonic
(2) Values are based on 25 mm (1.0 in.) wide strip tensile strength per D7747 for laboratory tested specimens

U.S. Standard Units

Table 5(a) - Seam Strength of Thermally Bonded Chlorosulphonated Polyethylene Reinforced (CSPE-R) Geomembrane Seams Made According to GRI-GM28(2)

Property	Test Method	Min. Value	Min. Value	Min. Value
Sheet Thickness • nominal (mils)	D5199 (Method A)	 36	 45	 60
Hot Wedge/Air Seams(1) • shear strength (lb) • peel strength (lb)	D7747	 40 20	 50 20	 60 20
Other Seam Types • shear strength (lb) • peel strength (lb)	D7747	 40 20	 50 20	 60 20

(1) Also for other possible seaming methods, e.g., ultrasonic
(2) Values are based on 1.0 in. (25 mm) wide strip tensile strength per D7747 for laboratory tested specimens

SI (Metric) Units

Table 5(b) - Seam Strength of Thermally Bonded Chlorosulphonated Polyethylene Reinforced (CSPE-R) Geomembrane Seams Made According to GRI-GM28(2)

Property	Test Method	Min. Value	Min. Value	Min. Value
Sheet Thickness • nominal (mm)	D5199 (Method A)	 0.91	 1.14	 1.52
Hot Wedge/Air Seams(1) • shear strength (N) • peel strength (N)	D7747	 180 90	 220 90	 270 90
Other Seam Types • shear strength (N) • peel strength (N)	D7747	 180 90	 220 90	 270 90

(1) Also for other possible seaming methods, e.g., ultrasonic
(2) Values are based on 25 mm (1.0 in.) wide strip tensile strength per D7747 for laboratory tested specimens