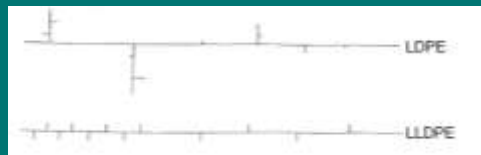


GRI-GM25 Specification -for- Scrim Reinforced Linear Low Density Polyethylene

- referred to as LLDPE-R
- three thickness categories as follows:
45, 36 and 24 mils (1.14, 0.91 and 0.61 mm)
- silent on method of manufacturing
- silent on type and weave of scrim
- specification lists properties, test methods, test values and testing frequencies

Regarding the Resin

- this is LLDPE and not LDPE
- eliminates branches in the PE backbone



- resin can be identified by melting point testing using a differential scanning calorimeter (DSC)
- field failures have occurred with LDPE
- the LLDPE properties are the same as GRI-GM17 for (nonreinforced) LLDPE geomembranes

Regarding the Categories

- three are listed; 1-severe, 2-moderate and 3-standard
- they are admittedly subjective
- meant to reflect type of handling, subgrade, backfill type and placement (if any), trafficking, equipment and maintenance

Required Material Properties

Physical Properties

1. thickness
2. weight

Mechanical Properties

3. grab strength
4. grab elongation
5. tongue tear
6. index puncture
7. ply adhesion

Endurance Properties

8. OIT
9. OIT after oven aging
10. OIT after UV incubation

1. Thickness

- follows ASTM D5199
- dead weight micrometer with flat tip
- measurement includes the scrim
- 10-specimens across roll width
- average must equal nominal
- min. ave. values are listed
- required for each roll



2. Weight

- correct term is mass per unit area
- follows ASTM D5261
- five specimens across roll width
- values averaged and compared to spec value stated as "min. ave."
- required for each roll



3&4: Grab Tensile Strength and Elongation

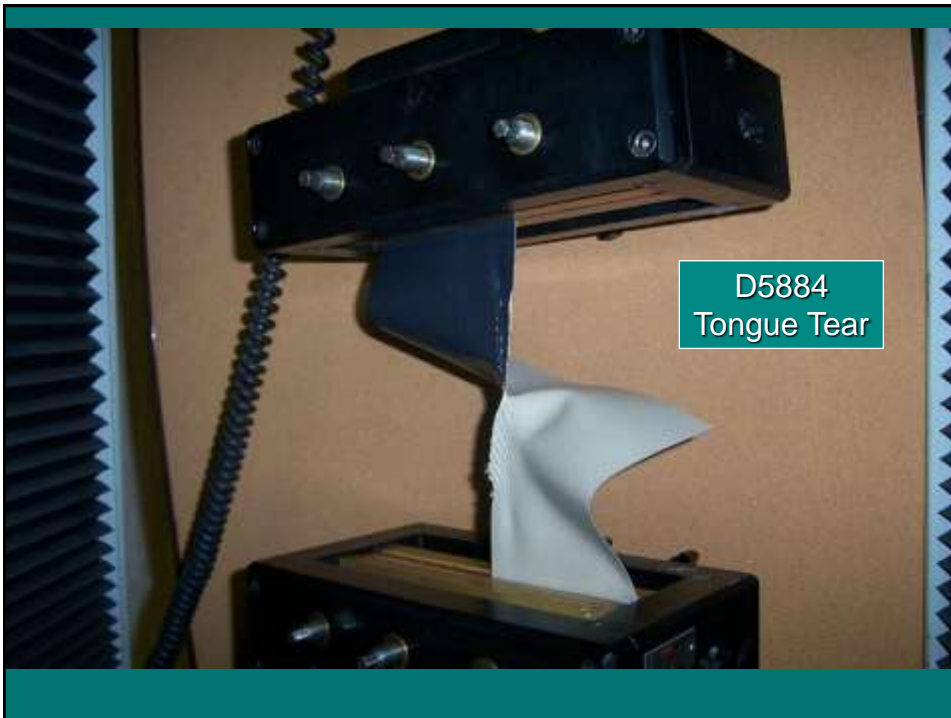
- follows ASTM D7004
- 4 in. (100 mm) wide specimen grabbed in the central 1 in. (25 mm)
- data reported in lb (or N), not lb/in. (or N/m)
- min. ave. of both 5 MD and 5 XMD
- every 30,000 lb (15,000 kg)



ASTM D7004 – Grab Tensile Test (Measures Strength and Elongation)

5. Tongue Tear Test

- uses ASTM D5884
- specimen 8 × 4 with 3 in. slit (200 × 100 with 75 mm slit)
- speed is 2.0 in./min (50 mm/min)
- average of 5MD and 5XMD
- every 30,000 lb (15,000 kg)



6. Puncture Resistance

- follows ASTM D4833
- called "pin" puncture
- min. ave. of 15-tests
- 380, 330, 290 N (85, 75, 65 lb)
- every 15,000 kg (30,000 lb) \approx 25 rolls



7. Ply Adhesion

- follows ASTM D6636
- min. ave. of 5 longitudinal tests
- requires 20 lb (9 N) min. ave.
- required every 30,000 lb (15,000 kg)

Ply Adhesion per ASTM D6636



8. Oxidative Induction Time

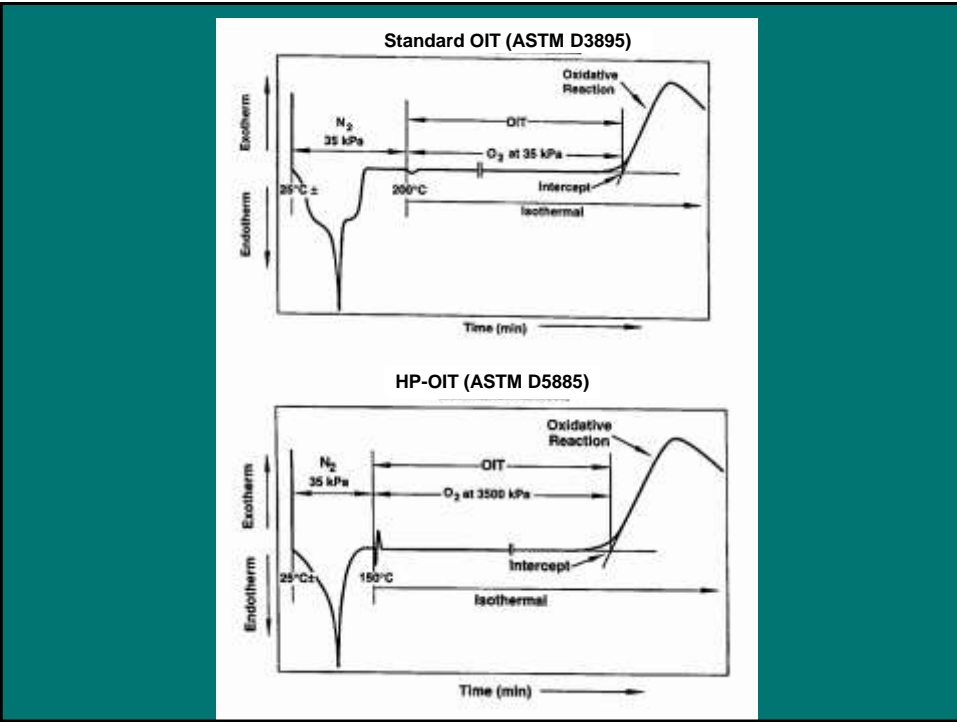
- OIT is an indirect measurement of the amount of antioxidants

Item	Standard	High Pressure
ASTM	D3985	D5885
Specimen	≈ 2 mg	≈ 2 mg
Pressure	35 kPa (5 lb/in ²)	3500 kPa (500 lb/in ²)
Temperature	200°C in N ₂ ; 1 min. dwell; switch to O ₂	150°C to N ₂ ; 1 min. dwell; switch to O ₂
Spec Value	≥ 100 min.	≥400 min.

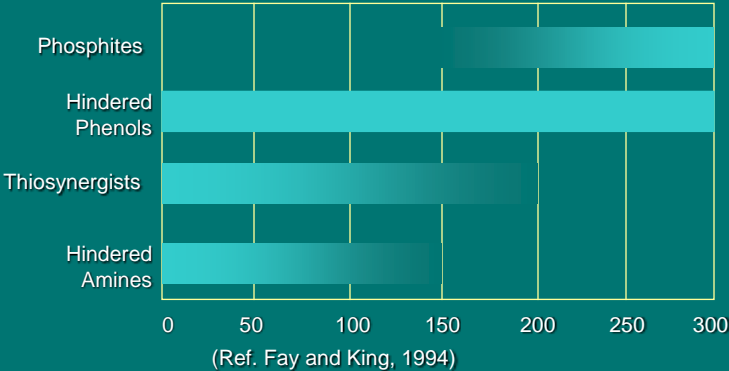
- challenges the amount and type of antioxidants (AO's)
- frequency is each formulation



High Pressure (Left) and Standard (Right) Cells for Measuring OIT



On choice of Std. or HP-OIT



- Std-OIT misrepresents AO packages with thiosynergists and/or hindered amines
- HP-OIT is always applicable (but \$10,000 cell and longer test time)

9. Oven Aging

- challenges the thermal stability of antioxidants (AOs), i.e., type of AO's
- follows ASTM D5721
- forced air oven at 85°C
- Std.-OIT \geq 35% ret. after 90 days exposure ... "or" ...
- HP-OIT \geq 60% ret. after 90 days
- frequency is per formulation



10. Ultraviolet Resistance

- challenges the UV stability of the AOs and CB (there should be synergy), i.e., type of AO's
- uses a laboratory weatherometer
- follows ASTM D7238
- called "ultraviolet fluorescent device"
- 20 hr. UV cycle at 75°C, then 4 hr. condensation at 60°C
- HP-OIT \geq 35% ret. after 1600 hrs.
- frequency is per formulation



Concluding Comments

- spec addresses scrim reinforced LLDPE-R
- resin/formulation is complimentary to GM17 for unreinforced fPP
- physical and mechanical properties are obviously different
- endurance properties are the same
- this is an MQC specification; if manufacturer's QC is more stringent use it, if not use this specification

The Basic Tables Follow

1(a) – U.S. Standard Units

1(b) – SI (Metric) Units

Note: The most recent version of this specification (text and tables) is on the GSI Website at

<http://www.geosynthetic-institute.org/specifications.htm>

Table 1 – Specification Values for Scream Reinforced Linear Low Density Polyethylene (LLDPE-R) Geomembranes

Property and Units	ASTM Test Method	Category 1 – Severe	Category 2 – Moderate	Category 3 – Standard	Testing Frequency Minimum
Thickness	D5199				
Nominal (mil)	-	45	36	24	per roll
min. ave. (mil)	-	40	32	20	
Weight	D5261				
Nominal (lb/1000 ft ²)	-	210	168	112	per roll
min. ave. (lb/1000 ft ²)	-	188	151	101	
Grab Tensile	D7004				
Strength (lb), min. ave. (each direction)	-	250	200	150	30,000 lb
Elongation (%), min. ave. (each direction)	-	22	22	22	30,000 lb
Tongue Tear (lb), min. ave. (each direction)	D3884	55	55	55	30,000 lb
Index Puncture (lb), min. ave.	D4833	85	75	65	30,000 lb
Ply Adhesion (lb), min. ave.⁽¹⁾	D6636	20	20	20	30,000 lb
Oxidative Induction Time (OIT)⁽²⁾	D3895		100		formulation
(a) Standard OIT	-				
(b) High Pressure OIT	D5885		400		
Oven Aging at 85°C⁽³⁾	D5721				
(a) Standard OIT - % retained after 90 days ⁽⁴⁾	D3895		35		formulation
(b) High Pressure OIT - % retained after 90 days ⁽⁴⁾	D5885		60		
UV Resistance⁽⁵⁾	D7238		N.R. ⁽⁶⁾		formulation
(a) Standard OIT ⁽⁶⁾	D3895				
(b) High Pressure OIT - % retained after 1600 hours	D5885		35		

Notes:

- Alternatively, an acceptable ply adhesion is to have a film tearing bond occur within the sheet material.
- The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant effectiveness in the geomembrane.
- It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.
- UV resistance is based on percent retained value regardless of the original HP-OIT value.
- The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.
- Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.

Table 2 – Specification Values for Scream Reinforced Linear Low Density Polyethylene (LLDPE-R) Geomembranes

Property and Units	ASTM Test Method	Category 1 – Severe	Category 2 – Moderate	Category 3 – Standard	Testing Frequency Minimum
Thickness	D5199				
Nominal (mm)	-	1.14	0.91	0.61	per roll
min. ave. (mm)	-	1.02	0.81	0.51	
Weight	D5261				
Nominal (N/m ²)	-	10.0	8.0	5.4	per roll
min. ave. (N/m ²)	-	9.1	7.2	4.8	
Grab Tensile	D7004				
Strength (N), min. ave. (each direction)	-	1100	890	670	15,000 kg
Elongation (%), min. ave. (each direction)	-	22	22	22	15,000 kg
Tongue Tear (N), min. ave. (each direction)	D3884	240	240	240	15,000 kg
Index Puncture (N), min. ave.	D4833	380	330	290	15,000 kg
Ply Adhesion (N), min. ave.⁽¹⁾	D6636	90	90	90	15,000 kg
Oxidative Induction Time (OIT)⁽²⁾	D3895		100		formulation
(a) Standard OIT	-				
(b) High Pressure OIT	D5885		400		
Oven Aging at 85°C⁽³⁾	D5721				
(a) Standard OIT - % retained after 90 days ⁽⁴⁾	D3895		35		formulation
(b) High Pressure OIT - % retained after 90 days ⁽⁴⁾	D5885		60		
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