

# **MANUFACTURING QUALITY CONTROL**

**SALES OFFICE:**

**AGRU AMERICA, INC.**

**500 Garrison Road**

**Georgetown, SC 29440**

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**[www.agruamerica.com](http://www.agruamerica.com)**

## AGRU AMERICA, INC. - QA/QC

### Manufacturing – Quality Assurance/Quality Control

**AGRU AMERICA, Inc.** extrudes high density polyethylene (HDPE) and linear low density polyethylene (LLDPE) geomembrane, HDPE Geonet, and Geocomposite products at its plant located at 500 Garrison Road, Georgetown, South Carolina, 29440.

Our USA Manufacturing Quality Assurance Program is dependent on the utilization of an in-house laboratory which is, when necessary, complemented with testing performed by certified outside laboratories such as:

- Precision Geosynthetic Laboratories; Anaheim, CA  
Telephone (714) 520-9631; Fax (714) 520-9637
- TRI/Environmental, Inc.; Austin, Texas  
Telephone (512) 263-2101; Fax (512) 263-2558

And other GRI-LAP accredited laboratories.

### Raw Material – Manufacturer’s Certificate of Conformity

HDPE and LLDPE resin is supplied to our plant in bulk and subjected to the following procedures:

- Prior to shipment, our resin supplier submits a certificate of analysis. Once approved, the resin is released for shipment to our plant.
- One sample is taken from each rail car after arrival and tested as follows:  
Melt Index ASTM D1238 190°C, 2.16kg, and Density ASTM D792.
- Once the tests have been completed and results found to be in compliance with our requirements, the resin is then unloaded into our silo system.
- At this stage, our supplier has performed one battery of tests and Agru America has performed one to verify the manufacturer's certificate of analysis.
- Off specification resin is returned to the supplier.
- The Manufacturer’s MFI Test Data is reported on the Quality Certificate (Agru America’s MFI Testing is done to verify this data).

## **GEOMEMBRANE**

### The Extrusion Process

The resin is conveyed through a vacuum pump system and flexible hoses to a dryer hopper, feeding the resin by gravity into an 8-inch barrel. This barrel is divided into five heating zones, each heating zone being computer controlled and constantly monitored.

A screw in the barrel turns at a prescribed and monitored speed. It conveys the resin slowly to full plastication, and then the plasticated resin is fed through a manifold into a coat hanger die having a width of approximately 24 feet. The die lips are open to a prescribed distance governed by the thickness of the geomembrane to be extruded.

Exiting the die, the plasticated resin forms a controlled and monitored bead, which feeds into a chrome three-roll stack in a prescribed pattern. Each chrome roll is set at a prescribed temperature, controlled by water circulation.

Exiting the controlled cooling of the roll stack, the geomembrane travels down the take off haulers towards the winder. On the way to the take off, the liner is trimmed to bring the finished width to the applicable standard. Trimmings are granulated.

The trimmed edge of one side of the geomembrane is marked at every 3.28 ft with thickness, Agru America name and year of manufacture. This marking also serves as product identification.

The geomembrane is visually inspected for surface defects as it travels down the take off by both the extruder and the winder operators.

The geomembrane is wound on a recycled HDPE core having 6" ID (150mm), 7" OD (175mm) and 22'8" (6.8m) length. Each smooth roll weighs approximately 3,000 pounds (1360 kg). Microspike® rolls weigh approximately 3,200 pounds (1450 kg). All rolls are fitted with two nylon slings when shipped.

### **Post Extrusion Quality Control**

Once start-up conditions are over and commercial extrusion is initiated, post-production quality control comes into operation. A series of test procedures are performed based upon either our Standard Frequency of testing (attached), or frequencies required by customer specifications.

A sample approximately 11" by the full width of the geomembrane is taken from every roll. Based on the specified test frequencies, certain specimens are die cut, tested and the results summarized on the Quality Certificate issued by our Quality Control Department. The certificate is signed electronically by the Quality Control Manager. The Quality Control Manager reports directly to the President of the Company.

Rolls failing to comply with either Customer Project Specifications and/or our own latest revision to our published data sheets are set aside and re-classified as off-spec (Class B rolls).

Quality Certificates are provided for all rolls of geomembranes (sample smooth & Microspike® certificates are attached), with the exception of off-spec (Class B rolls).

Sometimes a third party Quality Assurance representative is mandated by the owner of a project to oversee our manufacturing QA. We gladly subscribe to this procedure and make all our records available 24 hours a day for the duration of the mandate.

The following roll identification items are reported in our Quality Certificate:

#### **Roll number**

(example)            **203366 -01**

First digit	machine
Second and third digits	week of year
Fourth digit	day of week (Monday=1, Sunday=7)
Last two digits	roll number (first roll of week is 01, etc.)

The two last digits separated from the others indicate the year the roll was produced.

Using the above key:

Roll #203366 -06 was produced on Liner Machine #2 on Wednesday in the third week in 2006.

**Product Description** (liner type: Smooth, Microspike<sup>®</sup>, Drain<sup>®</sup>, Super Gripnet<sup>®</sup>, etc.)

**Roll Length & Width in feet & meters**

**Raw material lot and/or batch number and supplier/product identification** (from Resin Manufacturer’s Certificate of Analysis – sample attached)

The following test results are reported in the Geomembrane Quality Certificate, derived from our Standard Test Frequency (attached) and/or supplied raw material manufacturer Certificates of Analysis:

Test / Method	Results Reported & Modifications to Standard (if any)
Thickness †ASTM D5199(Smooth), or †D5994(Textured) <b>(Both Modified)</b>	Minimum, Maximum, and Average Sheet Thickness in mm and mils. <b>Modification from Standard</b> = Measurements are taken upon sample reaching Lab Temperature Equilibrium.
Asperity Height †GRI GM12 <b>(Modified)</b> Textured liner only	Asperity height in mils <b>Modifications from Standard</b> = Edge samples are collected from the smooth/textured junction, <b>not</b> 1 foot from edge. ASTM D5994 specimens are used for this test, <b>not</b> direct placement.
Density †ASTM D792	Density in g/cc
Melt Flow Index †ASTM D1238	g/10minutes (Conditions =190°C, 2.16kg). <b>NOTE: Resin Manufacturer’s Certificate of Analysis result</b> is reported. Our testing verifies this result.
Carbon Black Content †ASTM D4218	% Carbon Black by weight
Carbon Black Dispersion †ASTM D5596	Category (Only near spherical agglomerates per GRI GM 13 & 17)
Tensile Strength †ASTM D6693 Type IV, 2 inches / minute <b>(Modified)</b>	Average Strength @ Yield in psi, ppi, & N/mm Average Strength @ Break in psi, ppi, & N/mm Average Elongation @ Yield in % Average Elongation @ Break in % <b>Modification from Standard</b> = Average of MD & TD results are reported <b>NOTE 1:</b> The D6693 results equate to the following <b>D638 Modifications:</b> Gage Length for Yield = 1.3”, for Break = 2” <b>NOTE 2:</b> Yield data not reported for LLDPE
Dimensional Stability †ASTM D1204 <b>(Modified)</b>	Average Dimensional Change in % <b>Modification from Standard</b> = Average Dimensional Change of MD & TD is reported. Test is run upon sample reaching Lab Temperature Equilibrium
Tear Resistance †ASTM D1004 <b>(Modified)</b>	Tear Resistance in Lbs & N. <b>Modifications from Standard</b> = Test is run upon sample reaching Lab Temperature Equilibrium. Average Tear Resistance of MD & TD is reported.
Puncture Resistance †ASTM D4833 †FTMS 101C Method 2065 <b>(Both Modified)</b>	Puncture Resistance in Lbs & N. <b>Modification from Standard</b> = Test is run upon sample reaching Lab Temperature Equilibrium.
Environmental Stress Crack Resistance (ESCR) †ASTM D1693 <b>(CERTIFIED)</b>	This test is n longer run by Agru America, and the result is now certified by Agru America for 1500 hours (Certification letter is attached, as well as GAI-LAP’s approval of the certification.)
Notched Constant Tensile Load †ASTM D5397 (Single Point, Appx.)	Pass / Fail at 300 hours (or as required by customer specifications) This test run on HDPE only, and on smooth edge of textured liners.
Oxidative Induction Time (OIT) †ASTM D3895 Standard, 200°C, 1atm.	OIT Time in minutes. <b>Modification from Standard</b> = One run only – if result is below 120 minutes, a second run is done to verify the first.

†GRI-LAP Accredited for this method (INCLUDING Modifications)

The following Test methods are also performed per railcar in our Standard MQC, but results are **not** reported on our Quality Certificates (results can be forwarded if necessary).

<b>Test / Method</b>	<b>Results Reported</b>
Low Temperature Brittleness ASTM D746 <b>THIS TEST OUTSOURCED TO AN ACCREDITED 3<sup>rd</sup> PARTY LAB</b>	Pass / Fail for each specimen (5 specimens in both MD & TD), % of samples passing. <b>NOTE:</b> Standard MQC Temperature tested to is <b>-60°C</b> . Lower Temperatures can be done if required by customer specifications.

**Additional Test Procedures**  
**(Available if Specified from GRI-LAP Accredited Third Party Labs)**

Hydrostatic Resistance	ASTM D751
Volatile Loss	ASTM D1203
Resistance to Soil Burial	ASTM D3083 using ASTM D638 Type IV dumbbell at 2"/min.
Water Absorption	ASTM D570
Coefficient of Thermal Expansion	ASTM D696
Friction Angle Direct Shear Method	ASTM D5321
Moisture Vapor Transmission Rate 100°F - 100% RH	ASTM E96
Transmissivity (Profiled) Various gradients & confining pressure	ASTM D4716
Multi-axial Tensile Strain at Rupture (percent)	ASTM D5617
Modulus of Elasticity (or 2% Secant Modulus)	ASTM D638 (Modulus) or ASTM D5323

## **Drainage Net (Geonet)**

AGRU America drainage net is made from a blend of high quality virgin HDPE and a carbon black masterbatch. The purpose of the carbon black is to protect the plastic from UV damage in the field application.

All raw materials as well as the finished products are consistently monitored by specially trained lab technicians. Raw materials are tested as above for Geomembrane.

The blend of raw materials is plasticized by an extruder, which presses the melt through a screen changer to filter out impurities. The plastic is then fed into a rotating die which creates the net. The cooling of the net takes place in a water tank at a tightly controlled temperature. A series of nip rollers pull the net out of the tank and through the downstream equipment to the winders. The net is cut to length automatically and wound onto a 4" OD cardboard core.

Before the finished rolls are taken out of the winder frame, the quality control technician either releases the material into stock or classifies the material as scrap.

When approved by QC, the rolls are stretch wrapped and transferred to the storage yard.

## **Geocomposite**

In addition to the drainage net, AGRU America offers geocomposites which consist of geotextiles laminated to one or both sides of the net.

All geotextiles used for this lamination process are being inspected to meet AGRU America's (or project) specifications.

The lamination process takes place just before the net reaches the winders at the end of the extrusion line. After melting the surface of the HDPE drainage net, a geotextile is pressed into the net by means of a calender. The outer 6 inches of net are not laminated and the geotextile overlaps the net by an additional 6 inches on both sides of the product.

Before the finished rolls are taken out of the winder frame, the quality control technician either releases the material into stock or classifies the material as scrap.

When approved by QC, the rolls are stretch wrapped and transferred to the storage yard.

All drainage net and geocomposite rolls are labeled as follows:

- one label on each face of the roll
- two hand written roll numbers on the stretch wrap packaging
- one label on the laboratory sample
- numbering system is as above for geomembrane

The following test results are reported in the Geonet/Composite Quality Certificate, derived from our Test Results and/or supplied raw material manufacturer Certificates of Analysis:

<b>Test / Method</b>	<b>Results Reported &amp; Modifications to Standard (if any)</b>
Thickness (Geonet) †ASTM D5199	Minimum, Maximum, and Average Geonet Thickness in mm and mils. <b>Modification from Standard</b> = Measurements are taken upon sample reaching Lab Temperature Equilibrium. English Units reported
Density (Geonet) †ASTM D792	Geonet Density in g/cc
Melt Flow Index (Geonet) †ASTM D1238	g/10minutes (Conditions =190°C, 2.16kg). <b>NOTE: Resin Manufacturer's Certificate of Analysis result</b> is reported. Our testing verifies this result.
Carbon Black Content (Geonet) †ASTM D4218	% Carbon Black by weight
Peak Tensile Strength (Geonet) †ASTM D5035 or †ASTM D7179 <b>(Both Modified)</b>	MD Only tested, TD upon request only. Peak Strength @ Break in ppi <b>Modification from Standard</b> = English Units reported
Mass Per Unit Area (Geonet) †ASTM D5261	Average Mass per Unit Area in lb/ft <sup>2</sup> <b>Modification from Standard</b> = English Units reported
Transmissivity (Geonet) †ASTM D4716	Transmissivity, m <sup>2</sup> / sec Plate to Plate , 21°C, <b>gradient = 1.0, load = 15,000psf, seat time = 15 minutes</b> is Agru America's Standard Geonet MQC Transmissivity test (may be changed per project MQC specs)
Transmissivity (Geocomposite) †ASTM D4716	Transmissivity, m <sup>2</sup> / sec Plate to Plate , 21°C, <b>gradient = 0.1, load = 10,000psf, seat time = 15 minutes</b> is Agru America's Standard Geocomposite MQC Transmissivity test (may be changed per project MQC specs)
Ply Adhesion (Geocomposite) †ASTM D7005	Peel Strength, lbs/in, min. ave.

†GRI-LAP Accredited for this method (INCLUDING Modifications)

# Standard Frequency of Testing



## Product Data

Property	Test Method	Frequency of testing (minimum)*
Thickness (min. ave.), mil	ASTM D5994/D5199	per roll
Asperity Height (min. ave.), mil	GRI GM-12 (for textured liner)	per roll, alternating top/bottom for dbl sided textured liner only
Density, g/cc, minimum	ASTM D792, Method B	200,000 lbs (railcar)
Tensile Properties (ave. both directions)	ASTM D6693, Type IV	
Strength @ Yield (min. ave.), lb/in width	2 in/minute	
Elongation @ Yield (min. ave.), % (GL=1.3in)	5 specimens in each direction	20,000 lbs
Strength @ Break (min. ave.), lb/in width		
Elongation @ Break (min. ave.), % (GL=2.0in)		
Tear Resistance, lbs. (min. ave.)	ASTM D1004	45,000 lbs
Puncture Resistance, lbs. (min. ave.)	ASTM D4833	45,000 lbs
Carbon Black Content (range in %)	ASTM D4218	20,000 lbs
Carbon Black Dispersion (Category)	ASTM D5596	45,000 lbs
Stress Crack Resistance (NCTL), hours	ASTM D5397, Appendix	200,000 lbs (railcar)
Oxidative Induction Time, minutes	ASTM D3895, 200°C, 1 atm O <sub>2</sub>	200,000 lbs (railcar) on finished liner
Melt Flow Index, g/10 minutes	ASTM D1238, 190°C, 2.16kg	200,000 lbs (railcar) on incoming resin
Low Temperature Brittleness, °C	ASTM D746, -60°C	200,000 lbs (railcar) on finished liner
Oven Aging	ASTM D5721	
with HP OIT, (% retained after 90 days)	ASTM D5885, 150°C, 500psi O <sub>2</sub>	per resin formulation
UV Resistance	GRI GM11	
with HP OIT, (% retained after 1600 hours)	ASTM D5885, 150°C, 500psi O <sub>2</sub>	per resin formulation
2% Secant Modulus, lb/in. (max.)	ASTM D5323	per resin formulation- <b>for LLDPE liner only</b>
Axi-Symmetric Break Resistance Strain, % (min.)	ASTM D5617	per resin formulation- <b>for LLDPE liner only</b>

These test frequencies meet or exceed GRI's GM-13

\*Theses test frequencies may be changed based on project specifications, and represent the minimum MQC testing performed. Additional costs may be incurred if required testing is greater than listed above

All information, recommendations and suggestions appearing in this literature concerning the use of our products are based upon tests and data believed to be reliable; however, it is the user's responsibility to determine the suitability for their own use of the products described herein. Since the actual use by others is beyond our control, no guarantee or warranty of any kind, expressed or implied, is made by Agru/America as to the effects of such use or the results to be obtained, nor does Agru/America assume any liability in connection herewith. Any statement made herein may not be absolutely complete since additional information may be necessary or desirable when particular or exceptional conditions or circumstances exist or because of applicable laws or government regulations. Nothing herein is to be construed as permission or as a recommendation to infringe any patent.

Executive Offices: 500 Garrison Road, Georgetown, SC 29440    843-546-0600    800-321-1379    Fax: 843-546-0516  
 Sales Office: 700 Rockmead, Suite 150, Kingwood, TX 77339    281-358-4741    800-373-2478    Fax: 281-358-5297  
 email: salesmkg@agruamerica.com

## Certificate of Analysis

Shipped To: AGRU AMERICA INC  
500 GARRISON RD  
GEORGETOWN SC 29440  
USA

Recipient: GRANT PALMER  
Fax:

CPC Delivery #: 86671544  
PO #: 03814  
Weight: 190000 LB  
Ship Date: 07/14/2004  
Package: BULK  
Mode: Hopper Car  
Car #: GOCX058461  
Seal No: 301173

Product:  
MARLEX POLYETHYLENE K307 BULK

Lot Number: 8140404

Property	Test Method	Value	Unit
Melt Index	ASTM D1238	0.260	g/10mi
HLMI Flow Rate	ASTM D1238	22.00	g/10mi
Density	ASTM D1505	0.9380	g/cm3
Pellet Count	P02.08.03	30.000	pel/g
Production Date		3/22/04	

The data set forth herein have been carefully compiled by Chevron Phillips Chemical Company LP.  
**However, there is no warranty of any kind, either expressed or implied, applicable to its use, and the user assumes all risk and liability in connection therewith.**



Jackie Edwards  
Certification Systems Specialist

For CoA questions contact Carol Meza at 713-475-3625



# quality certificate

ROLL # **211351-06** Lot #: **MM193612** Liner Type: **MICROSPIKE™ HDPE**

Measurement ASTM D5994 (Modified)	METRIC	ENGLISH	Thickness.....	1.5 mm	60 mil
	MIN:	1.46 mm	57 mil	Length.....	125 m
	MAX:	1.81 mm	71 mil	Width.....	7.00 m; 23.0 feet
Asperity GRI GM12: <b>30</b> mil	AVE:	1.58 mm	62 mil		
ODD #: TOP EVEN #: BOTTOM				OIT(Standard) ASTM D3895 minutes	<b>143</b>

**TEST RESULTS**

Specific Gravity ASTM D792	Density	g/cc	<b>.944</b>
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MFI ASTM D1238 COND. E GRADE: <b>7002</b>	Melt Flow Index 190°C /2160 g	g/10 min	<b>.24</b>
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Carbon Black Content ASTM D4218	Range	%	<b>2.35</b>
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Carbon Black Dispersion ASTM D5596	Category		<b>1</b>
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Tensile Strength ASTM D6693 ASTM D638 (Modified) ( 2 inches / minute )	Average Strength @ Yield	<b>27</b> N/mm	<b>152</b> ppi	<b>2,448</b> psi
	Average Strength @ Break	<b>31</b> N/mm	<b>177</b> ppi	<b>2,842</b> psi

Elongation ASTM D6693 ASTM D638 (Modified) ( 2 inches / minute ) Lo = 1.3" Yield Lo = 2.0" Break	Average Elongation @ Yield	%	<b>17.46</b>
	Average Elongation @ Break	%	<b>502.2</b>

Dimensional Stability ASTM D1204 (Modified)	Average Dimensional change	%	<b>-.61</b>
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Tear Resistance ASTM D-1004 (Modified)	Average Tear Resistance	<b>245.1</b> N	<b>55.095</b> lbs
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Puncture Resistance FTMS 101 Method 2065 (Modified)	Load	<b>437.3</b> N	<b>98.324</b> lbs
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Puncture Resistance ASTM D4833 (Modified)	Load	<b>614.2</b> N	<b>138.08</b> lbs
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ESCR ASTM D1693	Minimum Hrs w/o Failures	1500 hrs	<b>CERTIFIED</b>
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Notched Constant Tensile Load ASTM D5397	pass / fail @ 30%	300 hrs	<b>ONGOING</b>
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Customer: **Environmental Specialties**  
 PO: **6208 Big Run Landfill**  
 Destination **Ashland, KY**

Date:..... **3-15-06** .....

Signature.....  .....

Quality Control Department

60HDmic.FRM  
REV 03  
12/23/05



# quality certificate

ROLL # **206769-06** Lot # **CSG812000** Liner Type:**SMOOTH LLDPE**

Thickness Measurement ASTM D5199 (Modified)	MIN:	METRIC	ENGLISH	Thickness	1.5mm	60mil	Length	128	m	420	feet
		mm	mil		Width	6.86		m	22.5	feet	
	MAX:	1.703	67								
	AVE:	1.558	61				OIT(Standard)	ASTM D3895	minutes	144	

Specific Gravity ASTM D792	Density		g/cc								<b>.937</b>
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MFI ASTM D1238 COND. E GRADE:	<b>7104</b>	Melt Flow Index 190°C /2160 g - g /10 min									<b>.32</b>
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Carbon Black Content ASTM D4218	Range		%								<b>2.46</b>
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Carbon Black Dispersion ASTM D5596	Category										<b>1</b>
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Tensile Strength ASTM D6693 ASTM D638 (Modified) ( 2 inches / minute )	Average Strength @ Break			<b>53</b>	N/mm	<b>300</b>	ppi	<b>5,005</b>	psi		
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Elongation ASTM D-6693 ASTM D638 (Modified) ( 2 inches / minute ) Lo = 1.3" Yield Lo = 2.0" Break	Average Elongation @ Break		%								<b>931.1</b>
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Dimensional Stability ASTM D1204 (Modified)	Average Dimensional Change		%								<b>-0.20</b>
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Tear Resistance ASTM D1004 (Modified)	Average Tear Resistance			<b>204</b>	N			<b>45.966</b>	lbs		
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Puncture Resistance FTMS 101 Method 2065 (Modified)	Load			<b>455</b>	N			<b>102.37</b>	lbs		
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Puncture Resistance ASTM D4833 (Modified)	Load			<b>550</b>	N			<b>123.56</b>	lbs		
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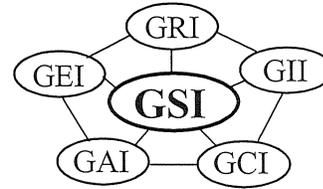
ESCR ASTM D1693	Minimum Hrs w / o Failures	1500 hrs						<b>CERTIFIED</b>			
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Customer:  
PO:  
Destination

Date:.....**2-13-06**.....  
Signature.....*[Signature]*.....

## ***Geosynthetic Institute***

475 Kedron Avenue  
Folsom, PA 19033-1208 USA  
TEL (610) 522-8440  
FAX (610) 522-8441



June 11, 2008

Mr. Grant Palmer  
Laboratory Director  
Agru-America Inc.  
500 Garrison Road  
Georgetown, SC 29440

Re: GAI-LAP Accreditation

Dear Grant:

The Geosynthetic Institute (GSI) is pleased to acknowledge Agru-America Inc. on its repertoire of Geosynthetic Accreditation Institute's-Laboratory Accreditation Program (GAI-LAP) accredited tests. This letter should serve as notification that Agru-America Inc. located in Georgetown, SC is currently accredited for the following twenty test methods until June 30, 2009.

1. ASTM D792 Test Method for Specific Gravity (Relative Density) and Density of Plastics by Displacement
2. ASTM D1004 Test Method for Initial Tear Resistance of Plastic Film and Sheeting
3. ASTM D1204 Test Method for Linear Dimensional Changes of Nonrigid Thermoplastic Sheeting or Film at Elevated Temperature
4. ASTM D1238 Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer
5. ASTM D1693 Test Method for Environmental Stress-Cracking of Ethylene Plastics
6. ASTM D3895 Test Methods for Oxidative-Induction Time of Polyolefins by Differential Scanning Calorimetry
7. ASTM D4218 Test Method for Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique
8. ASTM D4716 Test Method for Determining the (In-Plane) Flow Rate per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head
9. ASTM D4833 Test Method for Index Puncture Resistance of Geotextiles, Geomembranes and Related Products

10. ASTM D5035 Test Method for Breaking Strength and Elongation of Textile Fabrics (Strip Method)
11. ASTM D5199 Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes
12. ASTM D5261 Test Method for Measuring Mass per Unit Area of Geotextiles
13. ASTM D5397 Test Method for Evaluation of Stress Crack Resistance of Polyolefin Geomembranes using Notched Constant Tension Load Test
14. ASTM D5596 Test Methods for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics
15. ASTM D5994 Test Method for Measuring the Core Thickness of Textured Geomembranes
16. ASTM D6693 Test Method for Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembranes
17. ASTM D7005 Test Method for Determining the Bond Strength (Ply Adhesion) of Geocomposites
18. ASTM D7179 Test Method for Determining the Geonet Breaking Force
19. FTM STD. No. 101c (method 2065), Puncture Resistance and Elongation Test (1/8 in. radius probe)
20. GRI GM-12 Asperity Measurement of Textured Geomembranes Using a Depth Gage

A certificate to this affect has been enclosed, signed and sealed. Any questions regarding your accreditation should be directed to George or Robert Koerner at (610) 522-8440. Once again congratulation and thank you for participating in the GAI-LAP.

Best Regards,

A handwritten signature in black ink, appearing to read "George R. Koerner". The signature is fluid and cursive, with a long horizontal stroke at the end.

George R. Koerner, Ph.D., P.E. & CQA  
Director Designate GSI

Accreditation #:  
GAI-LAP - 26 - 1997  
TEL (610) 522-8440

Geosynthetic Institute  
475 Kedron, Ave.  
Folsom, PA 19033

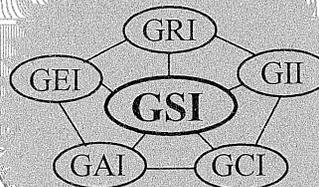


# Agru America, Inc.

*is granted accreditation  
for designated geosynthetic test methods in accordance with the  
Geosynthetic Accreditation Institute - Laboratory Accreditation Program  
(GAI-LAP), as published in its annual directory.  
This accreditation is valid until June 30, 2009.*

Robert M. Koerner, Ph.D., P.E.  
Director

George R. Koerner, Ph.D., P.E. & CQA  
Auditor



For more information and technical assistance contact:

Chevron Phillips Chemical Company LP  
P.O. Box 4910  
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PREMIUM EXTRUSION AND RIGID PACKAGING RESINS

## Marlex® K307

MEDIUM DENSITY POLYETHYLENE

This medium density, high molecular weight hexene copolymer is tailored for geomembrane applications that require:

- Outstanding ESCR
- Broad fusion range
- Excellent melt strength
- Good processability

Typical geomembrane applications for K307 include:

- Landfill liners
- Gasoline and chemical tank containment liners
- Tunnel moisture barriers
- Mine tailing collection projects

This resin meets these specifications:

- ASTM D4976 - PE 225
- GRI-GM13 except carbon black requirements
- FDA 21 CFR 177.1520(c) 3.1a, use conditions C through G per 21 CFR 176.170(c). Volume of food contacting article must be equal to or greater than 5 gallons.

NOMINAL PHYSICAL PROPERTIES <sup>(1)</sup>	English	SI	Method
Density	---	0.937 g/cm <sup>3</sup>	ASTM D1505
Flow Rate (HLMI, 190/21.6)	---	21.0 g/10 min	ASTM D1238
Tensile Strength at Yield, 2 in/min, Type IV bar	2,900 psi	20 MPa	ASTM D638
Elongation at Break, 2 in/min, Type IV bar	800%	800%	ASTM D638
Flexural Modulus, Tangent - 16:1 span:depth, 0.5 in/min	120,000 psi	830 MPa	ASTM D790
ESCR, Condition B (10% Igepal), F <sup>50</sup>	>1,500 h	>1,500 h	ASTM D1693
ESCR, Condition C (100% Igepal), F <sup>50</sup>	>1,500 h	>1,500 h	ASTM D1693
SP-NCTL	>900 h	>900 h	ASTM D5397 (Appendix)
Durometer Hardness, Type D (Shore D)	57	57	ASTM D2240
Vicat Softening Temperature, Loading 1, Rate A	221°F	105°C	ASTM D1525
Heat Deflection Temperature, 66 psi, Method A	137°F	58°C	ASTM D648
Brittleness Temperature, Type A, Type I specimen	<-103°F	<-75°C	ASTM D746
Tensile Impact, Type S bar	190 ft•lb/in <sup>2</sup>	400 kJ/m <sup>2</sup>	ASTM D1822

1. The nominal properties reported herein are typical of the product, but do not reflect normal testing variance and therefore should not be used for specification purposes. Values are rounded. The physical properties were determined on compression molded specimens that were prepared in accordance with Procedure C of ASTM D4703, Annex A1.

MSDS #240370

Revision Date July, 2004

Another quality product from



Before using this product, the user is advised and cautioned to make its own determination and assessment of the safety and suitability of the product for the specific use in question and is further advised against relying on the information contained herein as it may relate to any specific use or application. It is the ultimate responsibility of the user to ensure that the product is suited and the information is applicable to the user's specific application. Chevron Phillips Chemical Company LP does not make, and expressly disclaims, all warranties, including warranties of merchantability or fitness for a particular purpose, regardless of whether oral or written, express or implied, or allegedly arising from any usage of any trade or from any course of dealing in connection with the use of the information contained herein or the product itself. The user expressly assumes all risk and liability, whether based in contract, tort or otherwise, in connection with the use of the information contained herein or the product itself. Further, information contained herein is given without reference to any intellectual property issues, as well as federal, state or local laws which may be encountered in the use thereof. Such questions should be investigated by the user.



## **Resin Supplier Plant Locations**

**Chevron Phillips  
Cedar Bayou Chemical Complex      LLDPE 7104 resin (Geomembrane)  
9500 I-10 East Exit 796  
Baytown, TX  
77521-9570  
USA**

**Chevron Phillips  
Pasadena Plastics Complex      HDPE K307 resin (Geomembrane)  
1400 Jefferson Rd  
Pasadena, TX  
77506**

**Chevron Phillips      HDPE 5502BN resin (Geonet)**

# High Density Polyethylene Micro Spike® Liner



## Product Data

Property	Test Method	Values				
Thickness, nominal (mm)		30 (.75)	40 (1.0)	60 (1.5)	80 (2.0)	100 (2.5)
Thickness (min. ave.), mil (mm)	ASTM D5994*	29 (.71)	38 (.95)	57 (1.43)	76 (1.90)	95 (2.38)
Thickness (lowest indiv. for 8 of 10 spec.), mil (mm)	ASTM D5994*	27 (.68)	36 (.90)	54 (1.35)	72 (1.80)	90 (2.25)
Thickness (lowest indiv. for 1 of 10 spec.), mil (mm)	ASTM D5994*	26 (.64)	34 (.85)	51 (1.28)	68 (1.70)	85 (2.13)
<b>*The thickness values may be changed due to project specifications (i.e., absolute minimum thickness)</b>						
Asperity Height (min. ave.), mil (mm)	GRI GM12	16 (.41)	16 (.41)	16 (.41)	16 (.41)	16 (.41)
Density, g/cc, minimum	ASTM D792, Method B	0.94	0.94	0.94	0.94	0.94
Tensile Properties (ave. both directions)	ASTM D6693, Type IV					
Strength @ Yield (min. ave.), lb/in width (N/mm)	2 in/minute	66 (11.6)	88 (15.4)	132 (23.1)	176 (30.8)	220 (38.5)
Elongation @ Yield (min. ave.), % (GL=1.3in)	5 specimens in each direction	13	13	13	13	13
Strength @ Break (min. ave.), lb/in width (N/mm)		66 (11.6)	88 (15.4)	132 (23.1)	176 (30.8)	220 (38.5)
Elongation @ Break (min. ave.), % (GL=2.0in)		350	350	350	350	350
Tear Resistance (min. ave.), lbs. (N)	ASTM D1004	23 (102)	30 (133)	45 (200)	60 (267)	72 (320)
Puncture Resistance (min. ave.), lbs. (N)	ASTM D4833	60 (267)	90 (400)	120 (534)	150 (667)	180 (801)
Carbon Black Content (range in %)	ASTM D4218	2 - 3	2 - 3	2 - 3	2 - 3	2 - 3
Carbon Black Dispersion (Category)	ASTM D5596	Only near spherical agglomerates for 10 views: 9 views in Cat. 1 or 2, and 1 view in Cat. 3				
Stress Crack Resistance (Single Point NCTL), hours	ASTM D5397, Appendix	300	300	300	300	300
Oxidative Induction Time, minutes	ASTM D3895, 200°C, 1 atm O <sub>2</sub>	≥100	≥100	≥100	≥100	≥100
Melt Flow Index, g/10 minutes	ASTM D1238, 190°C, 2.16kg	≤1.0	≤1.0	≤1.0	≤1.0	≤1.0
Oven Aging	ASTM D5721	80	80	80	80	80
with HP OIT, (% retained after 90 days)	ASTM D5885, 150°C, 500psi O <sub>2</sub>					
UV Resistance	GRI GM11	20hr. Cycle @ 75°C/4 hr. dark condensation @ 60°C				
with HP OIT, (% retained after 1600 hours)	ASTM D5885, 150°C, 500psi O <sub>2</sub>	50	50	50	50	50

These product specifications meet or exceed GRI's GM13

## Supply Information (Standard Roll Dimensions)

Thickness		Width		Length		Area (approx.)		Weight (average)	
mil	mm	ft	m	ft	m	ft <sup>2</sup>	m <sup>2</sup>	lbs	kg
30	.75	23	7	600.1	182.9	13,782	1,280	3,325	1,510
40	1.0	23	7	600.1	182.9	13,782	1,280	3,325	1,510
60	1.5	23	7	410.1	125	9,419	875	3,356	1,522
80	2.0	23	7	328.1	100	7,535	700	3,306	1,500
100	2.5	23	7	246.1	75	5,651	525	3,167	1,436

### Notes:

All rolls are supplied with two slings. All rolls are wound on a 6 inch core. Special roll lengths are available on request.

All information, recommendations and suggestions appearing in this literature concerning the use of our products are based upon tests and data believed to be reliable; however, it is the users responsibility to determine the suitability for their own use of the products described herein. Since the actual use by others is beyond our control, no guarantee or warranty of any kind, expressed or implied, is made by Agru/America as to the effects of such use or the results to be obtained, nor does Agru/America assume any liability in connection herewith. Any statement made herein may not be absolutely complete since additional information may be necessary or desirable when particular or exceptional conditions or circumstances exist or because of applicable laws or government regulations. Nothing herein is to be construed as permission or as a recommendation to infringe any patent.

# High Density Polyethylene Smooth Liner™



## Product Data

Property	Test Method	Values				
Thickness (min. ave.), mil (mm)	ASTM D5199*	30 (.75)	40 (1.0)	60 (1.5)	80 (2.0)	100 (2.5)
Thickness (lowest indiv.), mil (mm)	ASTM D5199*	27 (.68)	36 (.90)	54 (1.35)	72 (1.80)	90 (2.25)
<b>*The thickness values may be changed due to project specifications (i.e., absolute minimum thickness)</b>						
Density, g/cc, minimum	ASTM D792, Method B	0.94	0.94	0.94	0.94	0.94
Tensile Properties (ave. both directions)	ASTM D6693, Type IV					
Strength @ Yield (min. ave.), lb/in width (N/mm)	2 in/minute	66 (11.6)	88 (15.4)	132 (23.1)	176 (30.8)	220 (38.5)
Elongation @ Yield (min. ave.), % (GL=1.3in)	5 specimens in each direction	13	13	13	13	13
Strength @ Break (min. ave.), lb/in width (N/mm)		120 (21)	160 (28)	240 (42)	320 (56)	400 (70)
Elongation @ Break (min. ave.), % (GL=2.0in)		700	700	700	700	700
Tear Resistance (min. ave.), lbs. (N)	ASTM D1004	23 (102)	30 (133)	45 (200)	60 (267)	72 (320)
Puncture Resistance (min. ave.), lbs. (N)	ASTM D4833	60 (267)	80 (356)	120 (534)	160 (712)	190 (845)
Carbon Black Content (range in %)	ASTM D4218	2 - 3	2 - 3	2 - 3	2 - 3	2 - 3
Carbon Black Dispersion (Category)	ASTM D5596	Only near spherical agglomerates for 10 views: 9 views in Cat. 1 or 2, and 1 view in Cat. 3				
Stress Crack Resistance (Single Point NCTL), hours	ASTM D5397, Appendix	300	300	300	300	300
Oxidative Induction Time, minutes	ASTM D3895, 200°C, 1 atm O <sub>2</sub>	≥100	≥100	≥100	≥100	≥100
Melt Flow Index, g/10 minutes	ASTM D1238, 190°C, 2.16kg	≤1.0	≤1.0	≤1.0	≤1.0	≤1.0
Oven Aging	ASTM D5721	80	80	80	80	80
with HP OIT, (% retained after 90 days)	ASTM D5885, 150°C, 500psi O <sub>2</sub>					
UV Resistance	GRI GM11	20hr. Cycle @ 75°C/4 hr. dark condensation @ 60°C				
with HP OIT, (% retained after 1600 hours)	ASTM D5885, 150°C, 500psi O <sub>2</sub>	50	50	50	50	50

These product specifications meet or exceed GRI's GM13

## Supply Information (Standard Roll Dimensions)

Thickness		Width		Length		Area (approx.)		Weight (average)	
mil	mm	ft	m	ft	m	ft <sup>2</sup>	m <sup>2</sup>	lbs	kg
30	.75	23	7	803.8	245	18,461	1,715	3,050	1,383
40	1.0	23	7	649.6	198	14,919	1,386	3,075	1,395
60	1.5	23	7	419.9	128	9,645	896	3,006	1,364
80	2.0	23	7	321.5	98	7,384	686	3,067	1,391
100	2.5	23	7	249.3	76	5,727	532	3,006	1,364

### Notes:

All rolls are supplied with two slings. All rolls are wound on a 6 inch core. Special roll lengths are available on request.  
All roll lengths and widths have a tolerance of ±1%

All information, recommendations and suggestions appearing in this literature concerning the use of our products are based upon tests and data believed to be reliable; however, it is the users responsibility to determine the suitability for their own use of the products described herein. Since the actual use by others is beyond our control, no guarantee or warranty of any kind, expressed or implied, is made by Agru/America as to the effects of such use or the results to be obtained, nor does Agru/America assume any liability in connection herewith. Any statement made herein may not be absolutely complete since additional information may be necessary or desirable when particular or exceptional conditions or circumstances exist or because of applicable laws or government regulations. Nothing herein is to be construed as permission or as a recommendation to infringe any patent.

Items: 60 HDPE textured(Black), 80 HDPE smooth(Black), 100 HDPE smooth(Black)

1.6.B.3.a.i, page 3

- Liner Manufacturer's testing for Density on raw material and finished liner will be tested via ASTM D792 Method B, not Method A or D1505 as listed. Both of these density methods are acceptable per the GRI GM13&17 Standards, and Method B is the recommended method for D792.

Table 2.1, page 8

- Thickness for textured geomembrane is tested via ASTM D5994. D5994 is the preferred method in the GRI GM13&17, and is the only method listed for textured thickness.
- Liner Manufacturer's testing for Density on raw material and finished liner will be tested via ASTM D792 Method B, not Method A or D1505 as listed. Both of these density methods are acceptable per the GRI GM13&17 Standards, and Method B is the recommended method for D792.
- Carbon Black Content will be tested via ASTM D4218, not D1603 as listed. Both of these Carbon Content methods are listed as acceptable in the GRI GM13& 17 Standards.
- Carbon Black Content is typically spec'd as a range between 2-3%

2.2.A.1, page 8

- MFI testing is typically done per 200,000 lbs, and is not necessary at the frequency listed. If possible, please amend to "one (1) per two hundred thousand (200,000) pound".

2.2.B, page 9

- 2. Carbon Black Content will be tested via ASTM D4218, not D1603 as listed. Both of these Carbon Content methods are listed as acceptable in the GRI GM13& 17 Standards.
- 9. A roll list (showing roll numbers & total # of rolls) & roll quality certificates(showing MQC results) for each roll of geomembrane will be submitted after production of the material. A "Production Log" will not be submitted. Presenting the Manufacturers data is the manufacturer's responsibility; compiling it is CQA's.