MANUFACTURING QUALITY CONTROL

Agru GeoClay

SALES OFFICE:

AGRU AMERICA, INC.

500 Garrison Road

Georgetown, SC 29440

Toll Free: (800) 373-2478

Telephone: (843) 546-0600

Fax: (843) 527-2738

salesmkg@agruamerica.com

www.agruamerica.com

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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, Geosynthetic Clay Liners (GCL), HDPE Geonet, PP Geotextile and Geocomposite products at its three production plants located at 500 Garrison Road, Georgetown, South Carolina, 29440, 181 Hwy 521, Andrews, South Carolina, and 2000 East Newlands Drive, Fernley, Nevada, 89408.

Our USA Manufacturing Quality Assurance Program is dependent on the utilization of in-house laboratories in each plant which are, 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

Geotextiles and bentonite are used in the manufacture of geosynthetic clay liners:

- Prior to shipment, our bentonite supplier submits a certificate of analysis. Once approved, the bentonite is released for shipment to our plant.
- At least weekly one sample is taken from a rail car after arrival and tested as follows:
  Swell Index ASTM D5890, Fluid Loss ASTM D5891, Moisture Content ASTM D2216 and particle size ASTM C136.
- The woven geotextile component is manufactured by others and must meet all Agru minimum requirements before it is introduced into the manufacturing process.
- The nonwoven geotextile is made by Agru or by others. In either case, it is tested to assure it meets our minimum properties before it is introduced into the manufacturing process.
- Off specification bentonite and/or geotextile is returned to the supplier.
- The Manufacturer's moisture content test data is reported on the GCL Quality Certificate.

Geosynthetic Clay Liner (GCL)

The Manufacturing Process

The bentonite is conveyed through a vacuum pump system and flexible hoses to a hopper, gravity feeding the bentonite onto the surface of the lower geotextile. The upper geotextile is then introduced on top of the layer of bentonite. This three layer product (lower textile, bentonite and upper geotextile) then go through a needle board which locks in the bentonite by needle punching textiles from the top layer to the bottom layer and vice versa.

Exiting the needle board, the rolls of finished GCL go through a magnet and needle detection system to ensure that the finished product is needle free. If needles are detected, the roll is tagged for additional inspection.

In addition to a metal detector and alarm, the GCL is also visually inspected to ensure there are no other surface defects as the material travels through the manufacturing process.

A line on either edge of the GCL are placed 6 inches in from the edge. These lines represent the minimum amount of overlap that should be used during installation.

The GCL is wound on a recycled HDPE core having 6" ID (150mm), 7" OD (175mm) and length corresponding to roll width.

Each standard length roll weighs approximately 2,500 – 4,000 pounds (1130-1815 kg). Rolls are placed in UV resistant plastic bags and sealed on the open end to prevent hydration or loss of bentonite.

Post Manufacturing Quality Control

Once start-up conditions are over and commercial manufacturing 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 2' by the full width of the GCL is taken from every 40,000 SF (14 rolls). 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 GCLs, 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) **G13E383069**

G	1 3	E	3 8	3	0	6	9
PLANT ID	**YEAR**	**MACHINE ID**	**WEEK**	**DAY OF WEEK (MONDAY = 1)**	**COUNTER FOR WEEK**		

First digit	Plant (G=Georgetown / F=Fernley)
Second and Third digits	Year (13 = 2013)
Fourth digit	Machine ID
Fifth & Sixth digits	Week in the current year
Seventh digit	day of week (Monday=1, Sunday=7)
Last three digits	counter for the week (starts at 001)

Using the above key:

Roll #G13E383069 was produced in Georgetown, on Liner Machine E on Wednesday in the 38th week in 2013 (9/18/13).

Product Description GCL type: Agru GeoClay

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)

All GCL rolls are labeled as follows:

- roll stickers on the cores for each roll
- roll stickers on the outside of the finished roll
- written (paint pen) roll numbers on each face (flat ends)
- written (paint pen) roll numbers on the outside of the finished roll.

The following test results are reported in the GCL Quality Certificate, derived from our Standard Test Frequency (attached) and/or supplied raw material manufacturer Certificates of Analysis (Tests performed are the latest revisions of the Standards listed):

Test / Method	Results Reported & Modifications to Standard (if any)
Swell Index ASTM D5890	MARV is reported in ml/2 g min **Modification from Standard** =
Fluid Loss ASTM D5891 Textured liner only	%
Bentonite Mass per Unit Area ASTM D5993	lb/ft^2 Mass is reported at zero % moisture in units of lb/ft^2.
Tensile Strength ASTM D6768	lb/in Reported for machine direction only.
Peel strength ASTM D6496	lb/in Reported for machine direction only
Hydraulic conductivity ASTM D5887	cm/sec max. Tested using deaired, deionized water @ 5psi maximum confining stress and 2 psi head pressure.
Index Flux ASTM D5887	m^3/m^2/sec max Tested using deaired, deionized water @ 5psi maximum confining stress and 2 psi head pressure
Internal Shear Strength ASTM D6243	Psf Specimens are hydrated for 24 hours and sheared at 200 psf. Represents typical peak value.

The following Test Methods / Results are not certified by Agru America, as they are not required by the GRI GC3, and are not considered typical MQC tests.

Test / Method	Results Certified
Nominal Thickness ASTM D5199	mils
Index Puncture Resistance ASTM D4833	lbf