

QUALITY ASSURANCE | PV MODULE

QUALITY ASSURANCE | QA | TCLP REPORT

Date	Service	Product Type	Manufacturer
March 15, 2019	Quality Assurance	PV Module	LONGi
	Client Name	Project Name	Project Location
	Invenergy	Wilkinson	USA

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1. ABBREVIATIONS

CEA	Clean Energy Associates
EPA	Environmental Protection Agency
mg/l	Milligrams per liter
RCRA	Resource Conservation and Recovery Act
TCLP	Toxicity Characteristic Leaching Procedure
TUV	TUV Rheinland of North America

2. SUMMARY

General Information		
Customer / Contact	Invenergy	Paul Thienpont
Project Name	LONGi Module TCLP	
Supplier / Contact	LONGi	Tommy Biangang < biangang@longi-silicon.com >
Product Specification	LONGi Photovoltaic Module: Model LR6-72HBD	
Test Details		
Scope of Work	TCLP	
Test Period	March, 2019	
Laboratory	TÜV	TUV Rheinland of North America 2709 SE Otis Corley Dr, Suite 11 Bentonville, AR 72712
	Lab Manager	Mark Smith Central Laboratory Manager – Chemical msmith@us.tuv.com
Remarks		
Results	PASS None of the 8 metals considered in the TCLIP Method 1311 test protocol were found in quantity above the threshold for toxicity.	

The Resource Conservation and Recovery Act of 1976 (RCRA) required the US EPA to establish standards and regulations for the management and disposal of hazardous materials and wastes. The US EPA established a test protocol to determine whether or not an item (waste) may contain components that are considered toxic above set limits established by the RCRA and defined by 40 CFR 261.24¹. This test protocol, TCLP, is described as Method 1311² by the EPA. The test protocol can be applied to photovoltaic modules to ensure that the module, once considered as solid waste, does not leach toxins into the environment.

A sample of the LONGi module, Model LR6-72HBD, was subjected (by TÜV, an independent test laboratory accredited by A2LA³ for Chemical Testing – see Appendix) to Method 1311, during which the concentrations of 8 metals considered to be toxic above specific concentrations, were measured. In all cases, the concentrations were below the thresholds for toxicity.

¹ https://www.ecfr.gov/cgi-bin/text-idx?node=se40.26.261_124&rgn=div8

² <https://www.epa.gov/sites/production/files/2015-12/documents/1311.pdf>

³ <https://www.a2la.org/>

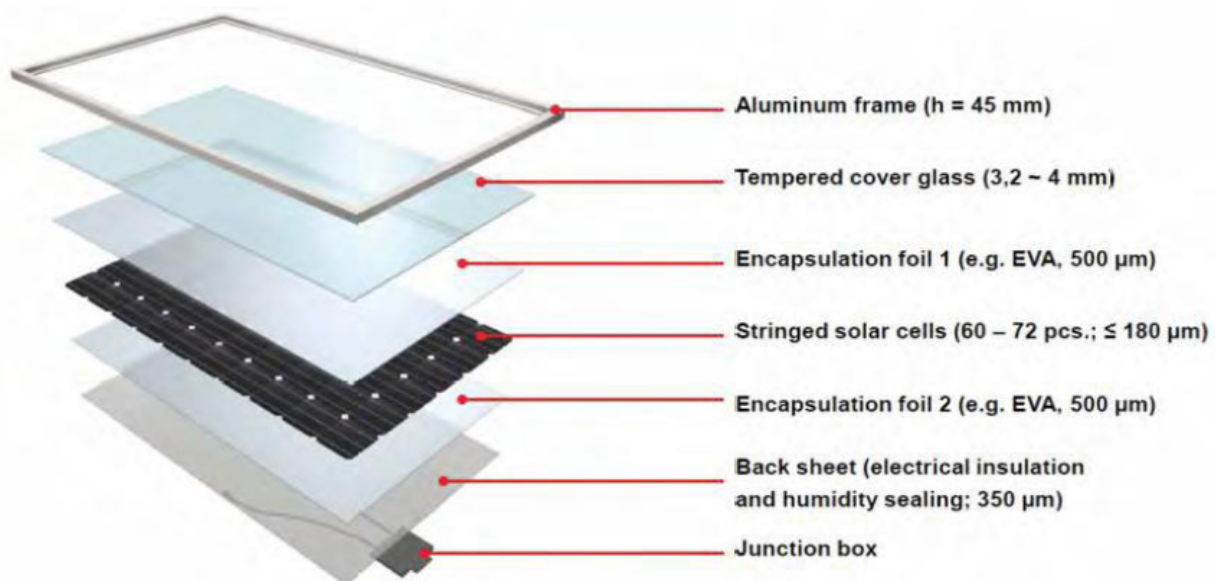
3. TEST OVERVIEW

Per Method 1311, “The TCLP is designed to determine the mobility of both organic and inorganic analytes present in liquid, solid, and multiphasic wastes.”

3.1. Sample Preparation

The sample consisted of all of the components used to assemble the photovoltaic module; the components were taken from a finished module. The module was assembled by LONGi in LONGi’s Kuching facility; the sample was taken at the same facility.

A typical PV module assembly, illustrated below, consist of glass, solar cells, encapsulant (akin to “glue” that holds all the parts together in a hermetic seal), wires and connectors; all surrounded by an aluminum frame. In the manufacturing process, solar cells are interconnected (stringed solar cells) and laid upon a layer of encapsulant (encapsulation foil) which is laid on a sheet of glass; another layer of encapsulant is placed on top of the cells and then the backsheet (in the case of the LONGi module, the backsheet is also glass). These layers are laminated together under heat and pressure. Afterwards, the junction box is adhered to the backsheet and the frame is adhered to the assembly.



Three parts of the Module were taken as the overall sample:

1. A section of the laminate, including the glass superstrate and substrate (top and bottom), the encapsulant, the cell and the interconnect wires (aka ribbons)
2. A section of the aluminum frame with the adhesive used to adhere the frame to the laminate
3. A complete junction box assembly, including the adhesive used to adhere the assembly to the substrate, the junction box, diodes, cables, connectors and potting compound.

As representative of a complete module, the items, in terms of weight percent, are identified in the following table:

Item	Weight (kg)	%
Laminate	22.6	85.3 %
Frame with sealant	3.7	14.0 %
J-box with potting and adhesive	0.2	0.7 %

The sample was sent to TUV via DHL (see photos below).



Figure 1: Section of laminate



Figure 2: Junction box assembly and frame section

Method 1311 calls for a test specimen of 100 mg. TUV prepared the components per Method 1311, in the weight percents provided above, and subjected the sample to the leaching test.

Eight (8) elements were measured during the Test.

The sample is placed in a vessel with an acetic acid / sodium hydroxide solution at a 1:20 mix of sample to solvent and tumbled for 18 hours (the intention is to simulate an extended leaching time for waste in the ground).

3.2. Results – Not Toxic

None of the 8 elements were found in concentrations that would characterize the solar module as toxic according to Method 1311. The TUV report is provided under separate cover. Results are presented below.

Metal	Threshold (mg/l)	Results (mg/l)	
Arsenic	<5.000	0.17	✓
Barium	<100.000	0.1	✓
Cadmium	<1.000	< 0.1	✓
Chromium	<5.000	< 0.1	✓
Lead	<5.000	3.64	✓
Mercury	<0.200	< 0.05	✓
Selenium	<1.000	< 0.1	✓
Silver	<5.000	< 0.5	✓

Other than disposal at the end of its useful life, a PV module can be recycled. The Solar Energy Industries Association has established a resource directory for recycling entities that are able and prepared to recycle PV modules. As of March 2019, there are 5 such recyclers identified.

4. APPENDIX A: Accreditation Certificate

Accredited Laboratory

A2LA has accredited

TUV RHEINLAND OF NORTH AMERICA, INC.

Bentonville, AR

for technical competence in the field of

Chemical Testing

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2005 *General requirements for the competence of testing and calibration laboratories*. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communiqué dated 8 January 2009).



Presented this 2nd day of June 2017.

A handwritten signature in black ink, appearing to be "L. J. ...", written over a horizontal line.

President and CEO
For the Accreditation Council
Certificate Number 3331.09
Valid to June 30, 2019

For the tests to which this accreditation applies, please refer to the laboratory's Chemical Scope of Accreditation.

5. APPENDIX B: TUV Lab Report

TEST REPORT

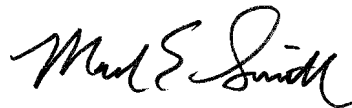
Date of Report: 3/18/2019
Project ID / Job Number: 234104875
Client: **Clean Energy Associates, LLC**
Address: **889 Julu Rd., Bldg 23, 5th floor
200040 Shanghai China**
Model Identification: **Model LR6-72HBD**
Item Description: Part of Module, 1 set of Jbox, Part of Frame
Number of Samples Submitted: 1
Additional Information: None
Test Parameters: **Toxicity Characteristic Leaching Procedure (TCLP)**
Date Received: 2/14/2019
Testing Period: 3/13/2019 – 3/18/2019
Delivery Condition: *Apparent Good*
Testing Location: TÜV Rheinland of North America
2709 SE Otis Corley Dr, Suite 11
Bentonville, AR 72712 USA
Other Aspects: N/A

Test Report Compiled by:



Cody Carson / Senior Chemist

Test Report Reviewed by:



Mark Smith / Laboratory Manager

Test result is drawn according to the kind and extent of tests performed. This test report is not permitted to be duplicated in extracts without permission of the test facility. This test report does not entitle any safety mark on this or similar products.

Test Parameters:

An aliquot of sample is leached with an acetic acid / sodium hydroxide solution at a 1:20 mix of sample to solvent. The leachate mixture is sealed in extraction vessel and tumbled for 18 hours to simulate an extended leaching time in the ground. It is then filtered and the solution is then analyzed for contaminants listed in Table 1.

RESULTS SUMMARY (Inorganic Analytes Only)

No analyte levels are at a concentration greater than or equal to those referenced in **Table 1**

EPA Waste Number	Contaminant	Regulatory Level (mg/L)
D004	Arsenic	5.000
D005	Barium	100.000
D006	Cadmium	1.000
D007	Chromium	5.000
D008	Lead	5.000
D009	Mercury	0.200
D010	Selenium	1.000
D011	Silver	5.000

Results:

Metal	Results (mg/L)
Arsenic	0.17
Barium	0.10
Cadmium	<0.10
Chromium	<0.10
Lead	3.64
Mercury	<0.05
Selenium	<0.10
Silver	<0.50

mg/L = Milligrams per liter (ppm)

Sample Photos:



Test Articles

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