

## **Test Report**

**Homogenous Sample Extraction per ASTM E3325 Standard and  
Toxicity Characteristic Leaching Procedure (TCLP) Testing per EPA 1311 Standard**

**Report No: R1-HLS221006.01**

**SolarPTL, LLC  
Tempe, Arizona**

**February 2023**

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## Report Information

<b>Test Report No.:</b>	<b>R1-HLS221006.01</b>				
<b>Client (Customer no. and address):</b>	488 Allen's Side Road Sault Ste. Marie, Ontario, Canada P6C 2L8				
<b>Test item:</b>	Photovoltaic (PV) Module(s)				
<b>Tested module type designation</b>	144HC M10 Bifacial module				
<b>Qualification by Similarity (QbS) module type designation(s)</b>	144HC M10 SL Bifacial; 108HC M10 SL Monofacial; 132HC M10 SL Monofacial; 156HC M10 SL Bifacial				
<b>Project No.:</b>	HLS221006.01				
<b>Test Specification:</b>	<b>Homogenous Sample Extraction per ASTM E3325 Standard &amp; Toxicity Characteristic Leaching Procedure (TCLP) Testing per EPA 1311 Standard</b>				
<b>Compiled By:</b>			<b>Reviewed By:</b>		
24 Feb. 2023	<b>Ashwini Pavgi</b> Project Engineer		24 Feb. 2023	<b>Dr. Govindasamy Tamizhmani</b> Reviewer	
<b>Date</b>	<b>Title/Name</b>	<b>Signature</b>	<b>Date</b>	<b>Title/Name</b>	<b>Signature</b>
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## Table of Contents

<b>DISCLAIMER .....</b>	<b>2</b>
<b>REPORT INFORMATION .....</b>	<b>3</b>
<b>TABLE OF CONTENTS.....</b>	<b>4</b>
<b>GENERAL INFORMATION .....</b>	<b>5</b>
<b>TEST SEQUENCE .....</b>	<b>6</b>
<b>SAMPLE EXTRACTION PER ASTM E3325:2021 .....</b>	<b>7</b>
SAMPLING.....	7
MODULE GROUP ASSIGNMENT.....	7
INSPECTION OF INCOMING MODULES.....	8
ESTIMATION OF NUMBER/TYPE PF PIECES PRIOR TO WATERJET CUTTING .....	9
IDENTIFICATION AND MARKING OF CUTTING LOCATIONS BEFORE WATERJET CUTTING.....	10
MODULES AFTER WATERJET CUTTING.....	11
SAMPLE SEGREGATION AND SELECTION FOR TCLP TESTING .....	11
CALCULATION NUMBER OF PIECES FOR TCLP TESTING BASED ON ACTUAL WEIGHT OF INDIVIDUAL CUT PIECES AND TYPES.....	12
<b>TCLP TESTING PER EPA 1311.....</b>	<b>13</b>
SAMPLE PREPARATION FOR TCLP TESTING .....	13
SENDING SAMPLES TO TCLP LAB.....	13
TCLP LAB'S TEST RESULTS AND PASS/FAIL VERDICT .....	15
<b>APPENDIX 1 .....</b>	<b>16</b>
<b>END OF REPORT .....</b>	<b>16</b>

**General information**

Test Item Particulars	
Accessories and detachable parts included in the evaluation	N/A
Mounting system used	N/A
Other options included	N/A
Possible Test Case Verdicts	
Test case does not apply to the test object	N/A
Test object does meet the requirement	P (Pass)
Test object does not meet the requirement	F (Fail)
Test was not required for this particular program	NR
General Remarks	
<ul style="list-style-type: none"><li>• This report shall not be reproduced, except in full, without the written approval of the testing laboratory.</li><li>• The test results presented in this report relate only to the item(s) identified in this report.</li><li>• "(see remark #)" refers to a remark appended to the report.</li><li>• "(see Annex #)" refers to an annex appended to the report.</li><li>• "(see appended table)" refers to a table in the test Report.</li><li>• Throughout this report a point is used as the decimal separator.</li></ul>	

## Test Sequence

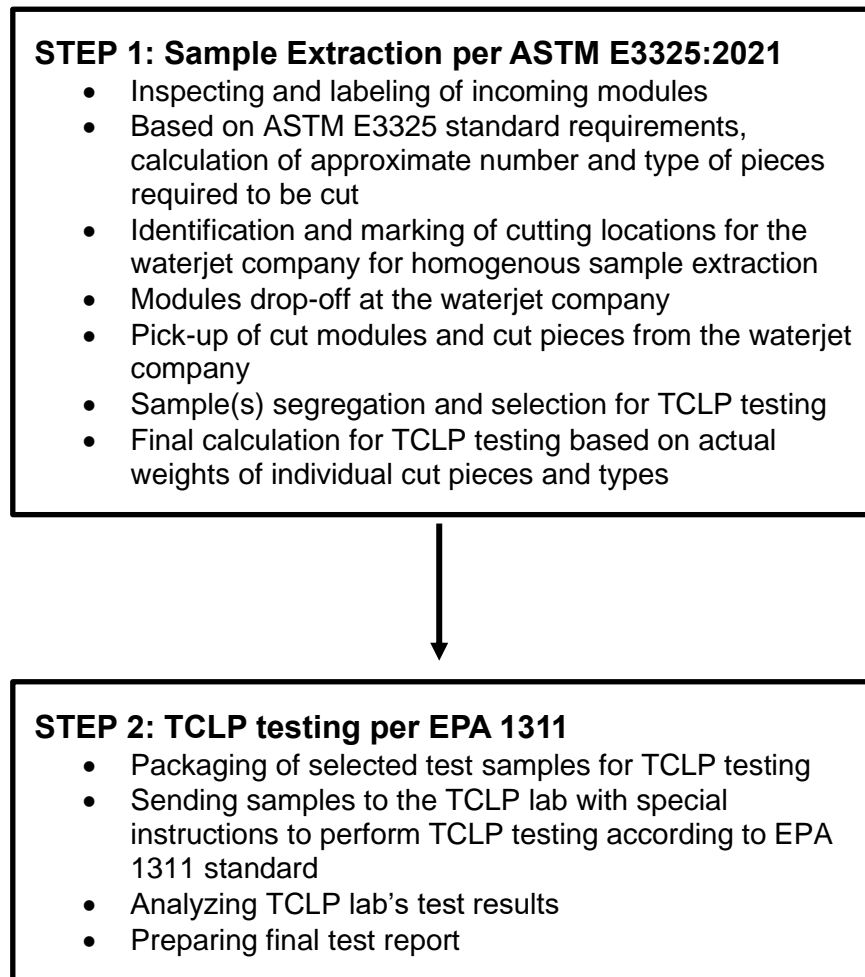


Fig. 1 TCLP Extraction and Testing Approach

## Sample Extraction per ASTM E3325:2021

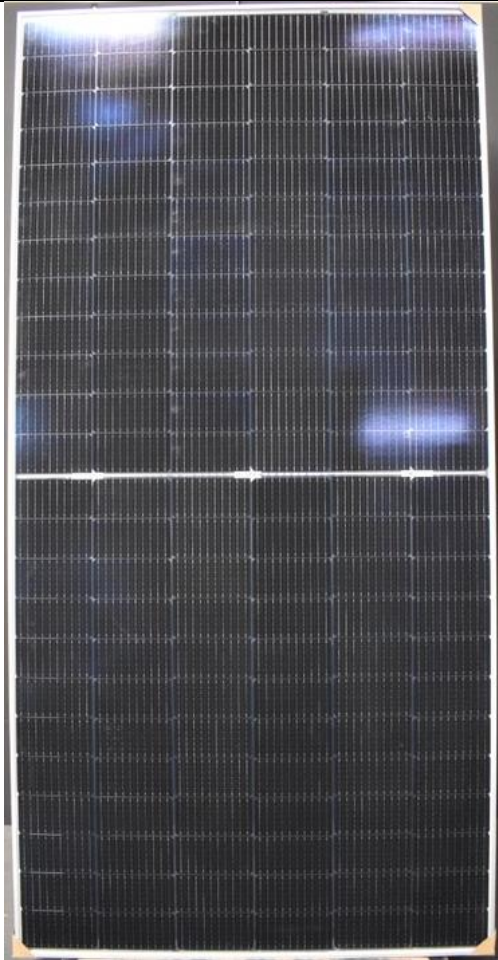

### Sampling

Sampling	
<input type="checkbox"/>	Random sampling from production
<input type="checkbox"/>	The modules tested were taken at random from a production batch and subjected to manufacturer's normal quality control and inspection for safety testing.
<input type="checkbox"/>	The modules tested were supplied by the manufacturer.
<input checked="" type="checkbox"/>	Prototype submitted by the client

### Module Group Assignment

Sample ID	Date Received (MM/DD/YYYY)	Serial Number	Type / Model Number	Test Specification
HLS0259	12/12/2022	13211100000020259	144HC M10 Bifacial module	No major defects
HLS0261	12/12/2022	13211100000020261	144HC M10 Bifacial module	No major defects
Supplementary Information: None.				

*Inspection of incoming modules*

Module #	Module Front Photograph	Module Back Photograph
HLS0259		



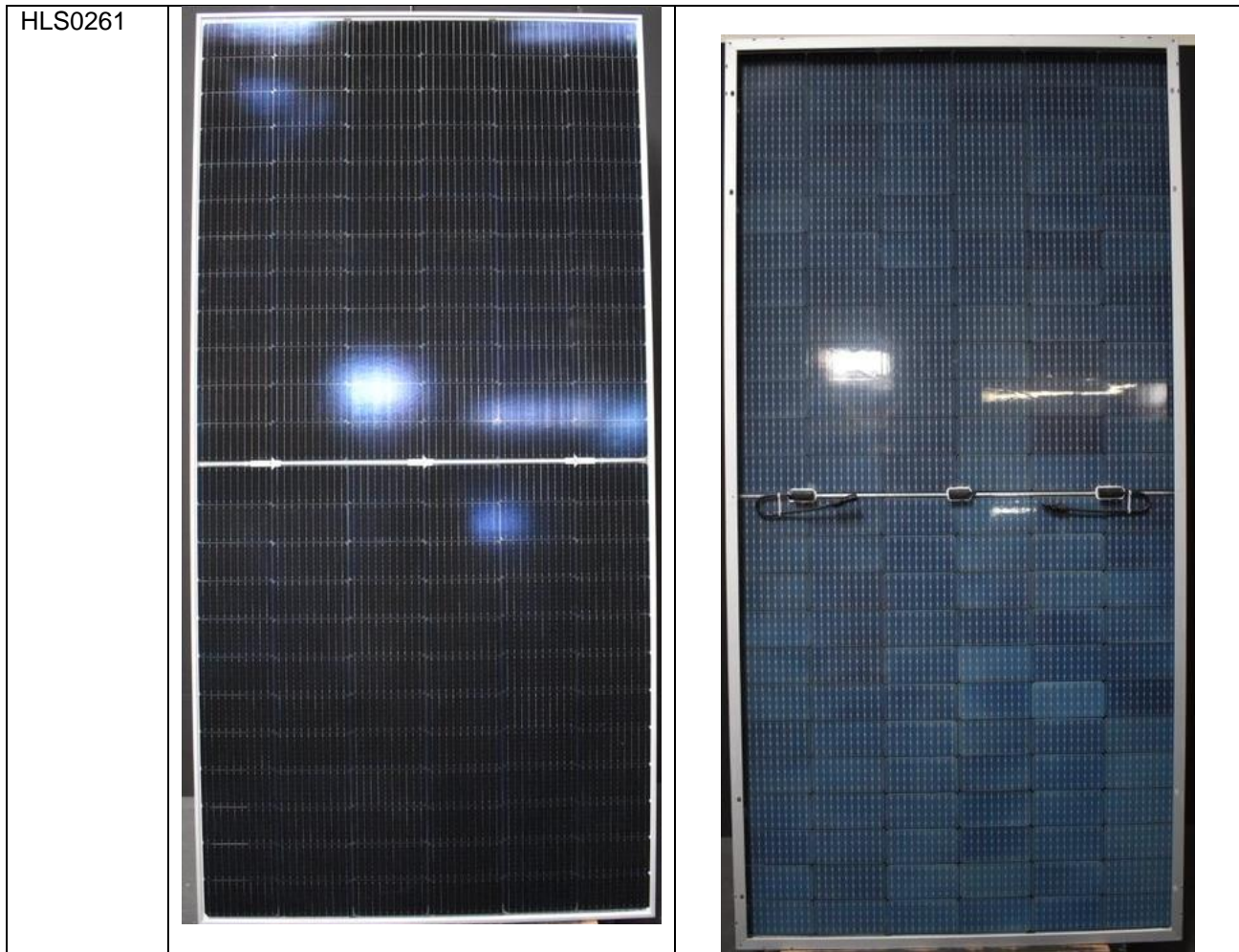


Fig 1: Incoming inspection of two modules (HLS0259 and HLS0261)

### ***Estimation of number/type of pieces prior to waterjet cutting***

Based on the ASTM E3325 standard requirements, an estimated number of pieces for each module region is calculated as shown in Table 1 prior to waterjet cutting. The four module regions are identified to be cut are: cell region, cell ribbon region, string ribbon region and non-cell/non-ribbon regions.

Module regions	Number of pieces
Cell Area	55
Cell Ribbon/Interconnect Area	65
String Ribbon/Interconnect Area	2
Non-Cell/Non-Ribbon/Interconnect Area	16
<b>Estimate TOTAL number of sample pieces</b>	<b>138</b>

Table 1: Number of pieces estimated for each region per module before waterjet cutting

## Identification and marking of cutting locations before waterjet cutting

SolarPTL identified and marked the four regions (cell region, cell ribbon region, string ribbon region and non-cell/non-ribbon region) for each module HLS0259 and HLS0261 as shown in Fig 2 and Fig 3 below.

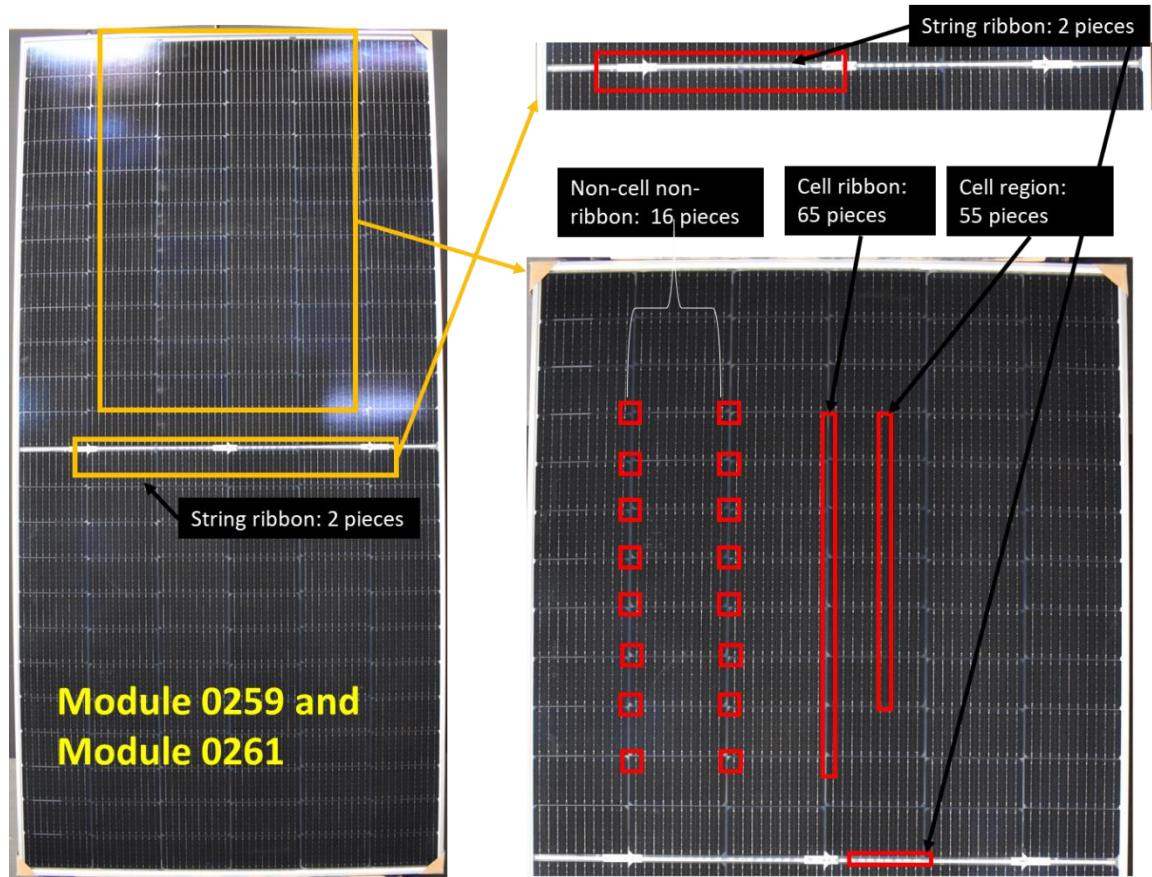


Fig. 2: Identification of four regions for cutting on each module

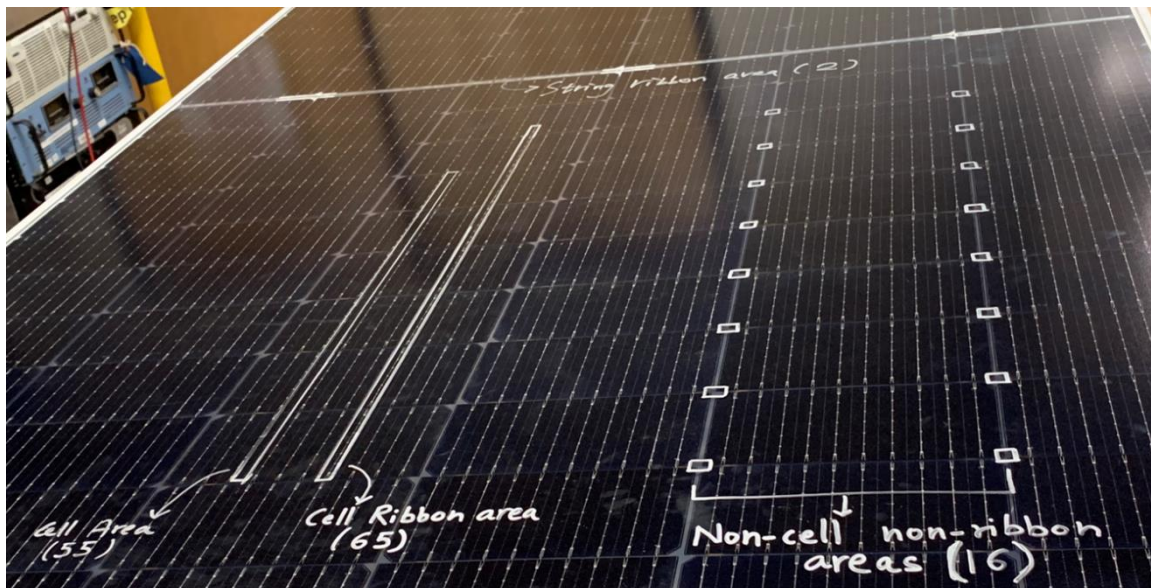


Fig. 3: Marking of four regions for cutting on each module prior to waterjet cutting



## Modules after waterjet cutting

Both the modules as shown in Fig 4 were picked up from the waterjet cutting company.



Fig 4: Module post-waterjet cutting process

## Sample segregation and selection for TCLP testing

The samples were segregated into four regions, rinsed with deionized water and dried in a convection oven at 50°C for 4 hours. Fig 5 and 6 shows one piece from each cut region with front and side details

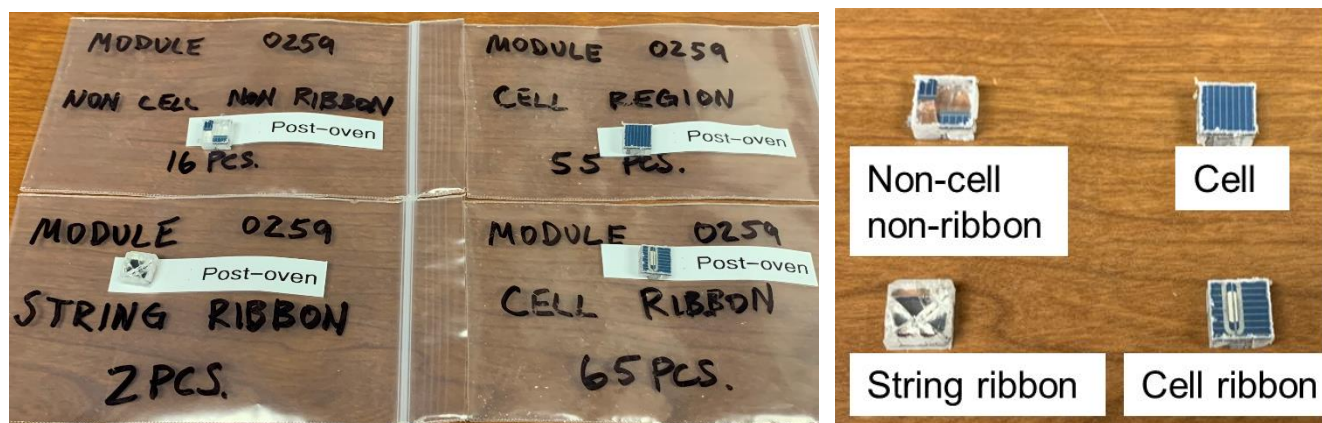
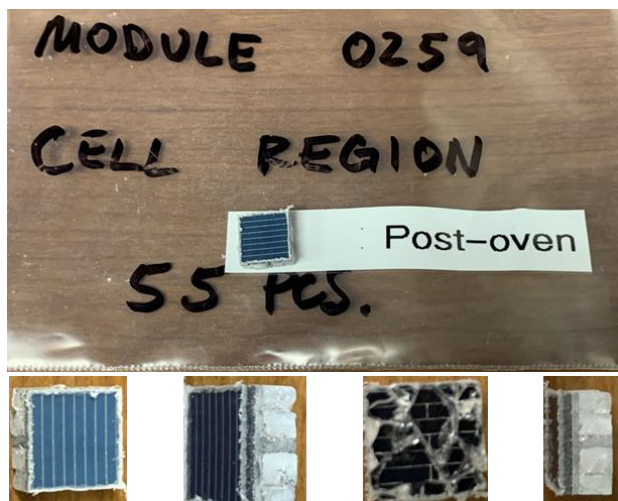
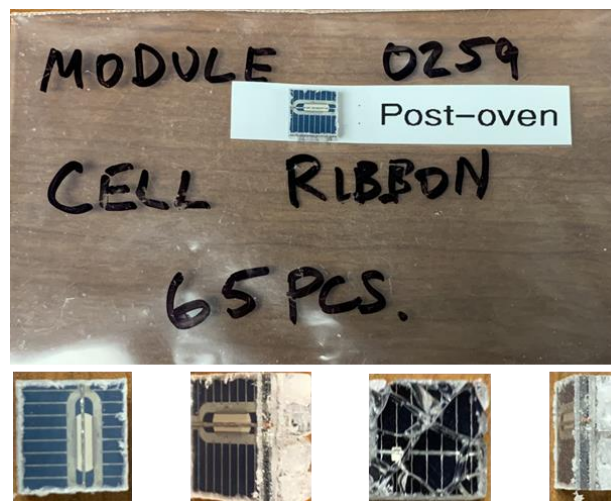


Fig. 5: Each region (cell, cell ribbon, string ribbon and non-cell non-ribbon) homogenous representative sample





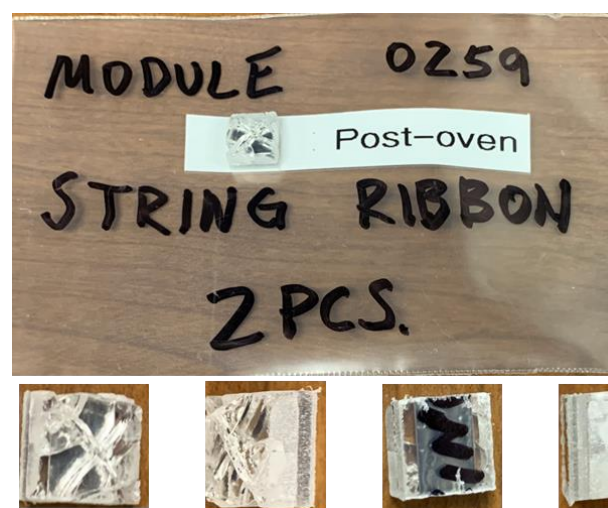
a. Cell region representative piece



b. Cell ribbon region representative piece



c. Non-cell non-ribbon representative piece



d. String ribbon representative piece

Fig. 6: Each region representative sample with front and side details

### Calculation number of pieces for TCLP testing based on actual weight of individual cut pieces and types

Module #	Cell regions	Average weight (gm)	Region representation (%)	No. of pieces	Total weight (gm)
HLS0259	String Ribbon	0.94	0.9	1	0.94
	Non Cell Non Ribbon	0.82	11.8	15	12.25
	Cell Region	0.81	39.5	51	41.17
	Cell Ribbon	0.83	47.8	60	49.81
	<b>Total number of pieces and weight</b>			<b>127</b>	<b>104.5</b>
HLS0261	String Ribbon	0.95	0.9	1	0.95
	Non Cell Non Ribbon	0.80	11.5	15	11.94
	Cell Region	0.82	40.0	51	40.82
	Cell Ribbon	0.81	46.8	60	48.72
	<b>Total number of pieces and weight</b>			<b>127</b>	<b>102.5</b>

Table 2: Number of pieces calculated for each region per module after waterjet cutting

## TCLP Testing per EPA 1311

### *Sample preparation for TCLP testing*

All the cut pieces were segregated as shown in Fig. 7.

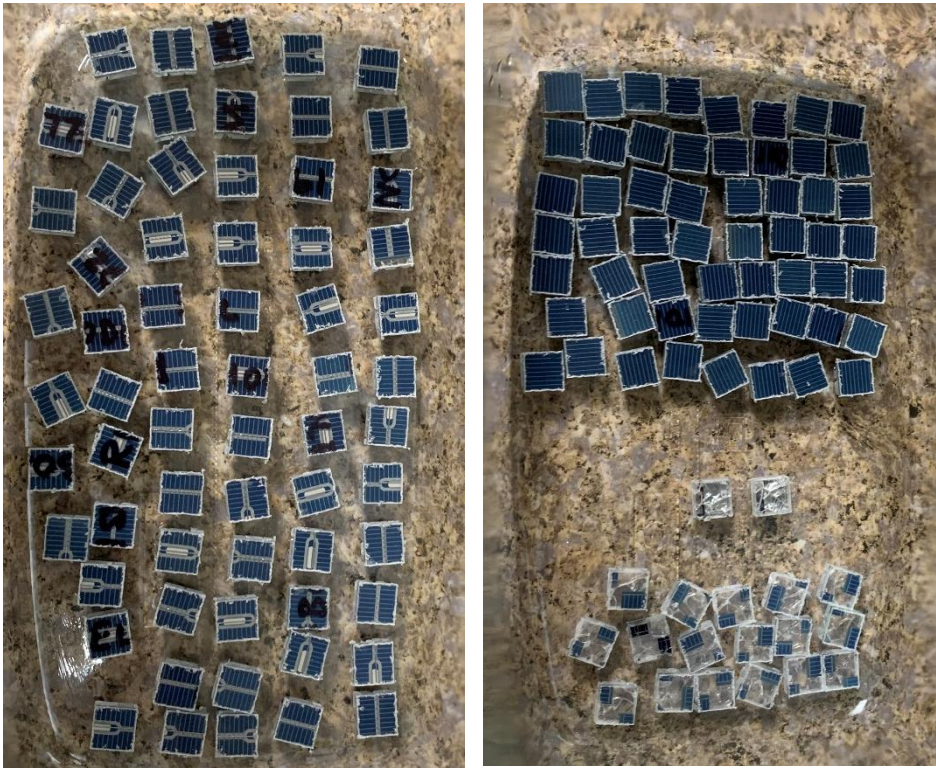


Fig. 7: Segregated post-dried pieces from cell ribbon region (left) and from cell, string ribbon and non-cell non-ribbon regions (right) to be packaged for sending to TCLP lab

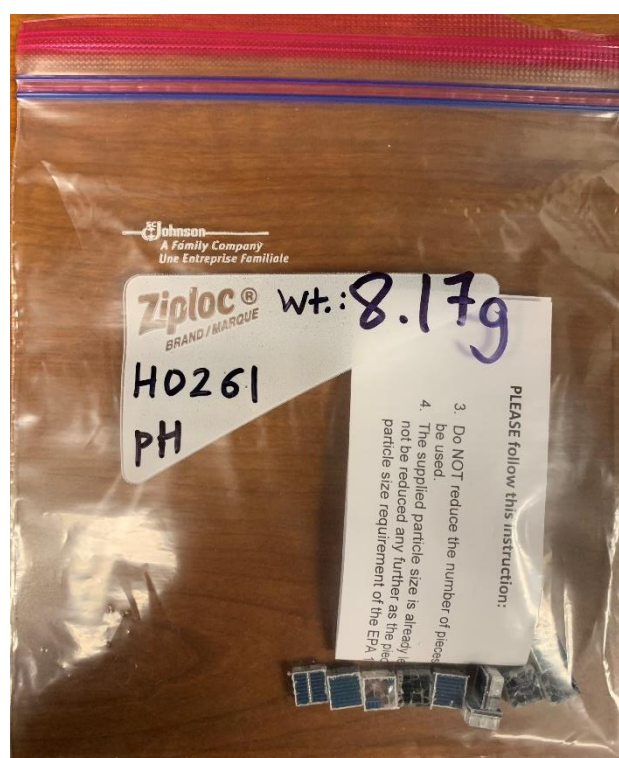
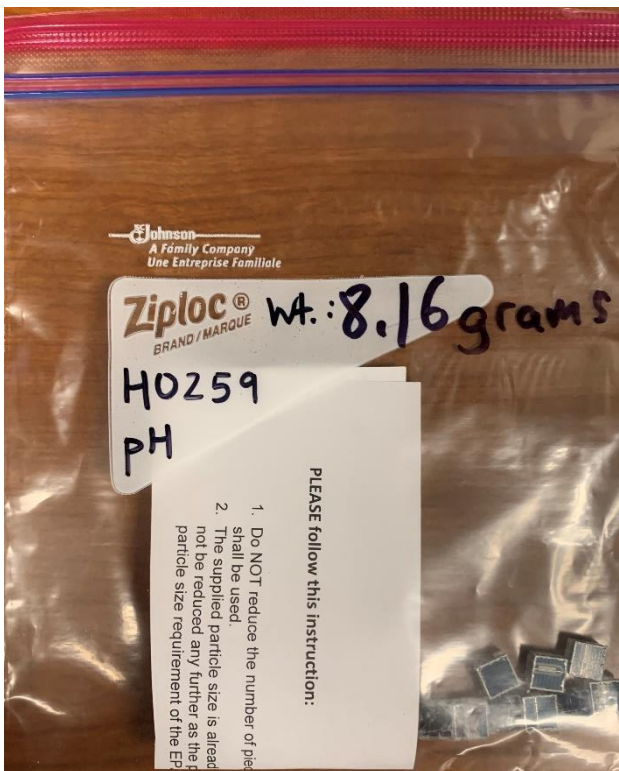
### *Sending samples to TCLP lab*

As shown in Table 2, the 127 selected pieces were placed in two plastic bags for modules HLS0259 and HLS0261 as shown in Fig 8 below. Also, about 8g of pieces for each module were placed in two additional plastic bags as shown in Fig 8 below for pH testing at the TCLP lab.





a. TCLP samples prepared for modules HLS0259 (104.5 g) and HLS0261 (102.5 g)



b. pH samples prepared for modules HLS0259 (8.16 g) and HLS0261 (8.17 g)

Fig 8: Samples packaged in ziploc bags sent to the TCLP lab for TCLP and pH testing

## TCLP lab's test results and pass/fail verdict

Table 3 and Table 4 show TCLP test results for modules HLS0259 and HLS0261, respectively. Based on the results presented in these tables, the analyte concentration for seven of the RCRA<sup>1</sup> metals (Mercury, Arsenic, Barium, Cadmium, Chromium, Selenium and Silver) is below the detection limit (ND = Not Detected; RDL = Reported Detection Limit). Only Lead is detected with an analyte concentration of 1.49 mg/l and 1.48 mg/l, respectively and it is way below the allowed limit of 5 mg/l.

### Mercury by Method 7470A

	Result	Qualifier	RDL	Limit
Analyte	mg/l		mg/l	mg/l
Mercury	ND		0.0100	0.20

### Metals (ICP) by Method 6010D

	Result	Qualifier	RDL	Limit
Analyte	mg/l		mg/l	mg/l
Arsenic	ND		0.100	5
Barium	ND		0.100	100
Cadmium	ND		0.100	1
Chromium	ND		0.100	5
Lead	1.49		0.100	5
Selenium	ND		0.100	1
Silver	ND		0.100	5

Table 3: TCLP test results for sample HLS0259

### Mercury by Method 7470A

	Result	Qualifier	RDL	Limit
Analyte	mg/l		mg/l	mg/l
Mercury	ND		0.0100	0.20

### Metals (ICP) by Method 6010D

	Result	Qualifier	RDL	Limit
Analyte	mg/l		mg/l	mg/l
Arsenic	ND		0.100	5
Barium	ND		0.100	100
Cadmium	ND		0.100	1
Chromium	ND		0.100	5
Lead	1.48		0.100	5
Selenium	ND		0.100	1
Silver	ND		0.100	5

Table 4: TCLP test results for sample HLS0261

**Pass/Fail Verdict:** Based on the sample extraction method per ASTM E3325:2021 standard and test results presented in Table 3 and 4, the tested modules HLS0259 and HLS0261 (from 144HC M10 Bifacial module type) are determined to have met the pass requirements of EPA<sup>2</sup> standards related to RCRA 8 Metals and TCLP. As per the declaration provided by the manufacturer (see Appendix 1), the following models/types are also determined to have met the pass requirements of EPA standards related to RCRA 8 Metals and TCLP: 144HC M10 SL Bifacial; 108HC M10 SL Monofacial; 132HC M10 SL Monofacial; 156HC M10 SL Bifacial

<sup>1</sup> RCRA, Resource Conservation and Recovery Act

<sup>2</sup> EPA, Environmental Protection Agency

## APPENDIX 1



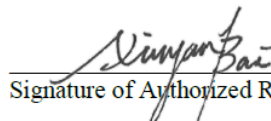
## LETTER OF DECLARATION

Date: Feb. 22<sup>nd</sup>, 2023

I, XINYAN BAI, do hereby certify that the information provided below is true and correct. I assert that I am an authorized signatory to sign this letter of declaration.

	Tested	QBS1	QBS2	QBS3	QBS4
Manufacturer Name	Heliene Inc.	Heliene Inc.	Heliene Inc.	Heliene Inc.	Heliene Inc.
Model #	144HC M10 Bifacial	144HC M10 SL Bifacial	108HC M10 SL Monofacial	132HC M10 SL Monofacial	156HC M10 SL Bifacial
Poly/Mono/etc.	Mono	Mono	Mono	Mono	Mono
Length of Module (in mm)	2279	2279	1725	2094	2464
Width of Module (in mm)	1134	1134	1134	1134	1134
Height of Module (in mm)	40	35	35	35	35
Groove thickness (mm) - default value	11	13.5	13.5	13.5	13.5
Number of Cells (e.g. 60 or 72)	144 Half Cell	144 Half Cell	108 Half Cell	132 Half Cell	156 Half Cell
Weight of Module (in kg)	29.2	29.2	21.5	27	31
Weight of Frame (in kg) - only if frame is included in testing, otherwise insert 0	0	0	0	0	0
Length of 1 cell (in mm)	182	182	182	182	182
Width of 1 cell (in mm)	91	91	91	91	91
Length of cell corner (in mm) (mono-crystalline cells only)	10.4	10.4	10.4	10.4	10.4
Width of cell corner (in mm) (mono-crystalline cells only)	5.2	5.2	5.2	5.2	5.2
Number of Cell Ribbon/Interconnects in 1 Cell	10	10	10	10	10
Length of 1 Cell Ribbon/Interconnect (in mm)	165	165	165	165	165
Width of 1 Cell Ribbon/Interconnect (in mm)	0.35	0.35	0.35	0.35	0.35
Number of String Ribbon/Interconnect 1 in Module	6	6	6	6	6
Length of String Ribbon/Interconnect 1 (in mm)	364	364	364	364	364
Width of String Ribbon/Interconnect 1 (in mm)	4	4	4	4	4
Number of String Ribbon/Interconnect 2 in Module	2	2	2	2	2
Length of String Ribbon/Interconnect 2 (in mm)	176	176	176	176	176
Width of String Ribbon/Interconnect 2 (in mm)	6	6	6	6	6
Number of String Ribbon/Interconnect 3 in Module	2	2	2	2	2
Length of String Ribbon/Interconnect 3 (in mm)	358	358	358	358	358
Width of String Ribbon/Interconnect 3 (in mm)	6	6	6	6	6

- Thickness of solder layer in the cell interconnect ribbon of the QbS (Qualification by Similarity) module(s) is equal to or lower than that of tested module
- Thickness of solder layer in the string interconnect ribbon of the QbS module(s) is equal to or lower than that of tested module
- Ratio of Sn/Pb (Sn/Pb = 60%/40%) in the string interconnect ribbon of the QbS module(s) is equal to or higher than that of tested module
- Ratio of Sn/Pb (Sn/Pb = 60%/40%) in the cell interconnect ribbon of the QbS module(s) is equal to or higher than that of tested module
- Laminate density (grams/cm<sup>2</sup>) in the QbS module(s) is uniform throughout the laminate area and is equal to or higher than that of tested module
- None of the following materials in the QbS module(s) [front glass, front and back encapsulant, cell, cell metallization, backsheet or back glass] contains any of the following eight metals: Hg, As, Ba, Cd, Cr, Pb, Se and Ag
- None of the following materials in the QbS module(s) [front glass, front and back encapsulant, cell, cell metallization, backsheet or back glass] is different from the tested module

  
Signature of Authorized Representative

Name of Authorized Representative: Xinyan Bai

Company Name: Heliene Inc.

Company Address: 488 Allens Side Rd, Sault Ste. Marie, ON P6C 2L8, Canada

End of Report