






MASTER COPY
WRITTEN IN RED

	 BHEL-EPD	ELECTRIC & PHOTOVOLTAIC DIVISION BENGALURU – 560012, INDIA Purchase Specification Group : Photovoltaic Module		SPEC. NO: PS-901-02-0001 REV. 05 JOB NO.-STD. PAGE 01 OF 04																																																				
		AR Coated GLASS – 3.2 mm Thick																																																						
		1.0 ITEM : AR (Anti Reflection) coated glass for PV modules 2.0 APPLICATION : for use in photovoltaic Modules to form superstrate and support cells during the lamination process. 3.0 TECHNICAL SPECIFICATIONS:																																																						
COPY RIGHT AND CONFIDENTIAL The information on this document is the property of Bharat Heavy Electricals Limited. It must not be used directly or indirectly in anyway detrimental to the interest of the company.	<table border="1"> <thead> <tr> <th>Sl No.</th> <th>Description</th> <th>Parameter</th> </tr> </thead> <tbody> <tr> <td>3.1</td> <td>Material state</td> <td>Tempered</td> </tr> <tr> <td>3.2</td> <td>Type</td> <td>AR coated on front side and textured on the other side.</td> </tr> <tr> <td>3.3</td> <td>Light Transmittance</td> <td>≥ 91.0 % transmission with bare glass, ≥ 93.5 % transmission with AR coated glass</td> </tr> <tr> <td>3.4</td> <td>Dimensions of Glass</td> <td>length : 1960 ± 1 mm, Width : 980 ± 1 mm, Thickness : 3.2 ± 0.2 mm</td> </tr> <tr> <td>3.5</td> <td>Diagonal Difference</td> <td>≤ 0.2 %</td> </tr> <tr> <td>3.6</td> <td>Fragmentation</td> <td>≥ 40 fragments</td> </tr> <tr> <td>3.7</td> <td>General Bow</td> <td>≤ 0.3 %</td> </tr> <tr> <td>3.8</td> <td>Local Bow</td> <td>≤ 0.4 % / 300 mm</td> </tr> <tr> <td>3.9</td> <td>Mechanical Strength (MPa)</td> <td>≥ 90</td> </tr> <tr> <td>3.10</td> <td>Falling ball Impact Resistance Test</td> <td>A steel ball with diameter of 38mm and weight 227g±2g falls down freely on the center of specimen from a distance of one meter, the specimen should not have any crack / breakage.</td> </tr> <tr> <td>3.11</td> <td>Young Modulus (GPa)</td> <td>≥ 70</td> </tr> <tr> <td>3.12</td> <td>Hardness</td> <td>≥ 6 Mohs, 470 Knoop (indenter load 500g)</td> </tr> <tr> <td>3.13</td> <td>Possion's ratio</td> <td>≈ 0.2</td> </tr> <tr> <td>3.14</td> <td>Thermal Resistant Impact Test</td> <td>No breakage up to 250 °C</td> </tr> <tr> <td>3.15</td> <td>Iron Content</td> <td>≤ 120 ppm</td> </tr> <tr> <td>3.16</td> <td>Density (Kg/m³)</td> <td>2500</td> </tr> </tbody> </table>					Sl No.	Description	Parameter	3.1	Material state	Tempered	3.2	Type	AR coated on front side and textured on the other side.	3.3	Light Transmittance	≥ 91.0 % transmission with bare glass, ≥ 93.5 % transmission with AR coated glass	3.4	Dimensions of Glass	length : 1960 ± 1 mm, Width : 980 ± 1 mm, Thickness : 3.2 ± 0.2 mm	3.5	Diagonal Difference	≤ 0.2 %	3.6	Fragmentation	≥ 40 fragments	3.7	General Bow	≤ 0.3 %	3.8	Local Bow	≤ 0.4 % / 300 mm	3.9	Mechanical Strength (MPa)	≥ 90	3.10	Falling ball Impact Resistance Test	A steel ball with diameter of 38mm and weight 227g±2g falls down freely on the center of specimen from a distance of one meter, the specimen should not have any crack / breakage.	3.11	Young Modulus (GPa)	≥ 70	3.12	Hardness	≥ 6 Mohs, 470 Knoop (indenter load 500g)	3.13	Possion's ratio	≈ 0.2	3.14	Thermal Resistant Impact Test	No breakage up to 250 °C	3.15	Iron Content	≤ 120 ppm	3.16	Density (Kg/m ³)	2500
	Sl No.	Description	Parameter																																																					
	3.1	Material state	Tempered																																																					
	3.2	Type	AR coated on front side and textured on the other side.																																																					
	3.3	Light Transmittance	≥ 91.0 % transmission with bare glass, ≥ 93.5 % transmission with AR coated glass																																																					
	3.4	Dimensions of Glass	length : 1960 ± 1 mm, Width : 980 ± 1 mm, Thickness : 3.2 ± 0.2 mm																																																					
	3.5	Diagonal Difference	≤ 0.2 %																																																					
	3.6	Fragmentation	≥ 40 fragments																																																					
	3.7	General Bow	≤ 0.3 %																																																					
	3.8	Local Bow	≤ 0.4 % / 300 mm																																																					
	3.9	Mechanical Strength (MPa)	≥ 90																																																					
	3.10	Falling ball Impact Resistance Test	A steel ball with diameter of 38mm and weight 227g±2g falls down freely on the center of specimen from a distance of one meter, the specimen should not have any crack / breakage.																																																					
	3.11	Young Modulus (GPa)	≥ 70																																																					
	3.12	Hardness	≥ 6 Mohs, 470 Knoop (indenter load 500g)																																																					
	3.13	Possion's ratio	≈ 0.2																																																					
	3.14	Thermal Resistant Impact Test	No breakage up to 250 °C																																																					
	3.15	Iron Content	≤ 120 ppm																																																					
3.16	Density (Kg/m ³)	2500																																																						
<table border="1"> <thead> <tr> <th>Revision (05):</th> <th>Issued By</th> <th>Prepared By</th> <th>Checked By</th> <th>Approved By</th> <th>Date</th> </tr> </thead> <tbody> <tr> <td></td> <td>SPV Eng.</td> <td>RKP <i>[Signature]</i></td> <td>AKS <i>[Signature]</i></td> <td>AKS <i>[Signature]</i></td> <td>02.05.19</td> </tr> </tbody> </table>						Revision (05):	Issued By	Prepared By	Checked By	Approved By	Date		SPV Eng.	RKP <i>[Signature]</i>	AKS <i>[Signature]</i>	AKS <i>[Signature]</i>	02.05.19																																							
Revision (05):	Issued By	Prepared By	Checked By	Approved By	Date																																																			
	SPV Eng.	RKP <i>[Signature]</i>	AKS <i>[Signature]</i>	AKS <i>[Signature]</i>	02.05.19																																																			


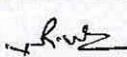

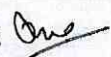
MASTER COPY
WHEN IN RED

	 BHEL-EPD	ELECTRIC & PHOTOVOLTAIC DIVISION BENGALURU – 560012, INDIA Purchase Specification Group : Photovoltaic Module				Spec. NO: PS-901-02-0001																																																																																																																												
						REV. 05	JOB NO.-STD.																																																																																																																											
		PAGE 02 OF 04																																																																																																																																
4.0 QUALITY OF GLASS SURFACE:																																																																																																																																		
<table border="1"> <tr> <th>Sl No.</th> <th colspan="6">Parameter</th> </tr> <tr> <td>4.1</td> <td colspan="6">Bubbles</td> </tr> <tr> <td>4.1.1</td> <td colspan="6">Open bubbles are not allowed.</td> </tr> <tr> <td rowspan="4">4.1.2</td> <td rowspan="4">Longitudinal Bubbles per m² (Number per size)</td> <td rowspan="2">Width (W) (mm)</td> <td colspan="4">Length (L) (mm)</td> </tr> <tr> <td>≤ 1.5</td> <td>1.5 < L ≤ 3.0</td> <td>3.0 < L ≤ 5.0</td> <td>> 5.0</td> </tr> <tr> <td>≤ 0.5</td> <td>10</td> <td>1</td> <td>0.5</td> <td>0</td> </tr> <tr> <td>0.5 < W ≤ 1.0</td> <td>5.5</td> <td>0</td> <td>0</td> <td>0</td> </tr> <tr> <td></td> <td>> 1.0</td> <td colspan="4">Not acceptable</td> </tr> <tr> <td rowspan="4">4.1.3</td> <td rowspan="4">Rounded Bubbles per m² (Number per size)</td> <td colspan="5">Φ < 0.5 mm : 15</td> </tr> <tr> <td colspan="5">0.5 ≤ Φ < 1.5 mm : 6 Nos.</td> </tr> <tr> <td colspan="5">1.5 ≤ Φ < 3.0 mm : 1 Nos.</td> </tr> <tr> <td colspan="5">Φ > 3.0 mm : Not acceptable</td> </tr> <tr> <td>4.2</td> <td colspan="6">Inclusions</td> </tr> <tr> <td>4.2.1</td> <td colspan="6">< 3*0.5 mm, which within 8 mm from edge and the distance over 300 mm are acceptable.</td> </tr> <tr> <td>4.2.2</td> <td colspan="6">< 3*0.5 mm, in the other area, normal sight from glass with distance is 100 mm, visible will be rejected</td> </tr> <tr> <td>4.2.3</td> <td colspan="6">> 3*0.5 mm, Not acceptable</td> </tr> <tr> <td rowspan="4">4.3</td> <td rowspan="4">Scratches</td> <td rowspan="2">Width (W) (mm)</td> <td colspan="3">Length (L) (mm)</td> <td rowspan="2">Depth of scratch ≤ 0.5 (mm)</td> </tr> <tr> <td>≤ 5</td> <td>5 < L ≤ 10</td> <td>> 10</td> </tr> <tr> <td>≤ 1.0</td> <td>4</td> <td>1</td> <td>0</td> </tr> <tr> <td>> 1.0</td> <td>0</td> <td>0</td> <td>0</td> </tr> <tr> <td>4.4</td> <td colspan="6">All corners to be rounded and edges to be ground.</td> </tr> </table>								Sl No.	Parameter						4.1	Bubbles						4.1.1	Open bubbles are not allowed.						4.1.2	Longitudinal Bubbles per m ² (Number per size)	Width (W) (mm)	Length (L) (mm)				≤ 1.5	1.5 < L ≤ 3.0	3.0 < L ≤ 5.0	> 5.0	≤ 0.5	10	1	0.5	0	0.5 < W ≤ 1.0	5.5	0	0	0		> 1.0	Not acceptable				4.1.3	Rounded Bubbles per m ² (Number per size)	Φ < 0.5 mm : 15					0.5 ≤ Φ < 1.5 mm : 6 Nos.					1.5 ≤ Φ < 3.0 mm : 1 Nos.					Φ > 3.0 mm : Not acceptable					4.2	Inclusions						4.2.1	< 3*0.5 mm, which within 8 mm from edge and the distance over 300 mm are acceptable.						4.2.2	< 3*0.5 mm, in the other area, normal sight from glass with distance is 100 mm, visible will be rejected						4.2.3	> 3*0.5 mm, Not acceptable						4.3	Scratches	Width (W) (mm)	Length (L) (mm)			Depth of scratch ≤ 0.5 (mm)	≤ 5	5 < L ≤ 10	> 10	≤ 1.0	4	1	0	> 1.0	0	0	0	4.4	All corners to be rounded and edges to be ground.					
Sl No.	Parameter																																																																																																																																	
4.1	Bubbles																																																																																																																																	
4.1.1	Open bubbles are not allowed.																																																																																																																																	
4.1.2	Longitudinal Bubbles per m ² (Number per size)	Width (W) (mm)	Length (L) (mm)																																																																																																																															
			≤ 1.5	1.5 < L ≤ 3.0	3.0 < L ≤ 5.0	> 5.0																																																																																																																												
		≤ 0.5	10	1	0.5	0																																																																																																																												
		0.5 < W ≤ 1.0	5.5	0	0	0																																																																																																																												
	> 1.0	Not acceptable																																																																																																																																
4.1.3	Rounded Bubbles per m ² (Number per size)	Φ < 0.5 mm : 15																																																																																																																																
		0.5 ≤ Φ < 1.5 mm : 6 Nos.																																																																																																																																
		1.5 ≤ Φ < 3.0 mm : 1 Nos.																																																																																																																																
		Φ > 3.0 mm : Not acceptable																																																																																																																																
4.2	Inclusions																																																																																																																																	
4.2.1	< 3*0.5 mm, which within 8 mm from edge and the distance over 300 mm are acceptable.																																																																																																																																	
4.2.2	< 3*0.5 mm, in the other area, normal sight from glass with distance is 100 mm, visible will be rejected																																																																																																																																	
4.2.3	> 3*0.5 mm, Not acceptable																																																																																																																																	
4.3	Scratches	Width (W) (mm)	Length (L) (mm)			Depth of scratch ≤ 0.5 (mm)																																																																																																																												
			≤ 5	5 < L ≤ 10	> 10																																																																																																																													
		≤ 1.0	4	1	0																																																																																																																													
		> 1.0	0	0	0																																																																																																																													
4.4	All corners to be rounded and edges to be ground.																																																																																																																																	
5.0 PACKING CONDITIONS:																																																																																																																																		
5.1 Glasses shall be individually interleaved with paper sheets. 5.2 The glasses shall be tightly packed in a wooden pallet suitable for seaworthy and roadworthy packing to avoid transit damages. The glasses should be covered with polythene sheets to avoid moisture and water entry and protected with silica gel Sachets adequately placed. 5.3 The wooden pallets shall be strong enough to handle the weight of glass on the pallet and loading in the Auto glass loader using forklifts in shop floor. The solid wood is preferred, however if plywood is opted, it shall be strong enough for withstanding the rigorous handling of shop floor and shall be anti-fungus treated.																																																																																																																																		
Revision (05):		Issued By	Prepared By	Checked By	Approved By	Date																																																																																																																												
		SPV Eng.	RKP 	AKS 	AKS 	02.05.19																																																																																																																												




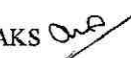
COPY RIGHT AND CONFIDENTIAL

The information on this document is the property of Bharat Heavy Electricals Limited. It must not be used directly or indirectly in anyway detrimental to the interest of the company.

MASTER COPY
WHEN IN RED

	 BHEL-EPD	ELECTRIC & PHOTOVOLTAIC DIVISION BENGALURU – 560012, INDIA Purchase Specification Group : Photovoltaic Module		SPEC. NO: PS-901-02-0001		
				REV. 05	JOB NO.-STD.	
				PAGE 03 OF 04		
COPY RIGHT AND CONFIDENTIAL The information on this document is the property of Bharat Heavy Electricals Limited. It must not be used directly or indirectly in anyway detrimental to the interest of the company.		<p>5.4 The size of pallet on width & length shall be at least 20 mm more than the size of glass on all the four sides in order to protect any impact to the glass stack during handling by forklifts.</p> <p>5.5 Each pallet shall be marked outside with Manufacturer name, Lot no, Date of Manufacture, size of the glass, BHEL PO number, Purchase Specification No. – PS-901-02-0001 and Quantity.</p> <p>6.0 TESTS CERTIFICATE / REPORTS / COC :</p> <p>6.1 Vendors has to provide valid Type Test reports for the Model no. / Variant quoted along with the tender documents for the parameters described in section 3.0, clause from 3.11 to 3.16, certified with TUV / UL / Testing labs complied with ISO / IEC 17025 for testing & accredited by NABL / ILAC / IECEE member signatory. The Type Test reports should have validity for five (5) year from the date of issue on receipt of purchase order and before effecting supplies.</p> <p>6.2 Vendor who don't have above Type Test reports shall submit undertaking for carrying out the tests & submit the Type Test reports within two weeks of technical bid opening date, failing which their offer shall be liable for rejection.</p> <p>6.3 Vendor has to perform and do the re-type test for the tests mentioned in the above section 6.0, clause no. 6.1 for the change in any chemical composition or change in process parameters.</p> <p>6.4 Each lot must be accompanied with routine Test Certificate, for the parameters described in section 3.0, clause from 3.1 to 3.10 & section 4.0, clause from 4.1 to 4.4.</p> <p>6.5 Certificate Of Compliance (COC) for each point mention under section 5.0, clause from 5.1 to 5.5 shall be provided along with each lot.</p> <p>6.6 Material safety data sheet shall be provided initially with Technical Offer and subsequently with the supplied lots along with dispatch documents.</p> <p>7.0 INSPECTION CRITERIA :</p> <p>7.1 Visual Inspection, Dimensional & Properties evaluation</p> <p>7.2 Single Sampling Plan as per ISO: 2859-1 / IS: 10673-1983, Special Inspection Level S-4, AQL 1.0</p> <p>7.3 BHEL reserves the right for pre-dispatch inspection at vendor works by BHEL or BHEL nominated agency.</p>				
		Revision (05):				
		SPV Eng.	RKP 	AKS 	AKS 	02.05.19

MASTER COPY
WHEN IN RED

	 BHEL-EPD	ELECTRIC & PHOTOVOLTAIC DIVISION BENGALURU – 560012, INDIA Purchase Specification Group : Photovoltaic Module		SPEC. NO: PS-901-02-0001 REV. 05 JOB NO.-STD. PAGE 04 OF 04			
COPY RIGHT AND CONFIDENTIAL The Information on this document is the property of Bharat Heavy Electricals Limited. It must not be used directly or indirectly in anyway detrimental to the interest of the company.		<p>7.4 BHEL at its discretion may waive the pre-dispatch inspection at vendors work based on review of submitted vendor inspection reports. However, the vendor responsibility is not absolved till the material is finally inspected and accepted at BHEL. Rejections if any at BHEL, vendor is liable to replace with good quality materials at vendor cost confirming with this purchase specification.</p> <p>7.5 Vendor to submit Manufacturing Quality Plan – MQP for review & approval on receipt of purchase order.</p>					
		Revision (05):	Issued By SPV Eng.	Prepared By RKP 	Checked By AKS 	Approved By AKS 	Date 02.05.19