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Technical specification of

LT power and Control cables for

10 MW (AC) Solar Photovoltaic Grid-connected Power plant

at Santaldih site (for WBSEDCL)

Approved: V Radhakrishnan

Prepared	*Issued*	Date
Phalguni Sahoo	PVCE	18/12/2017

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1.0 INTRODUCTION

This technical specification provides specifications for the supply of LT power and Control cables for solar power plant at Santaldih, WBSEDCL project.

2.0 List of cables:

Cable sl no	**Description**	**Quantity**
2.1	3.5-cx95 sq mm Cu conductor, XLPE insulation, Inner sheath of extruded PVC sheath ST-2 as per IS:5831, armoured cable and outer sheath of extruded FRLSH PVC ST-2 (UV-stabilised)	150 m
2.2	3.5-cx25 sq mm Cu conductor, XLPE insulation, Inner sheath of extruded PVC sheath ST-2 as per IS:5831, armoured cable and outer sheath of extruded FRLSH PVC ST-2 (UV-stabilised)	1100 m
2.3	4-cx2.5 sq mm Cu PVC insulated and armoured cable	12500 m
2.4	1cx25 sq mm Cu PVC insulated unarmoured cable	600 m
2.5	2-cx1.5 mm PVC insulated and sheathed unarmoured cable	4000 m
2.6	1-cx1.5 sq mm PVC insulated unarmoured cable	2000 m
2.7	2-pair 4 sq mm Cu cable, unarmoured PVC cable	1000 m
2.8	12-corex1.5 sq mm Cu instrumentation unarm cable: Cu conductor as per IS: 8130, class 5, collective screen of mylar tape. Inner sheath of Extruded PVC ST1to IS:5831. Outer sheath of extruded FRLSH PVC ST1 (UV-stabilised)	1000 m

3.0 Warranty: Vendor shall provide warranty for **12 months** from the date of commissioning or **18 months** from the date of supply, whichever is earlier. Vendor shall enclose, along with technical bid, the complete scope, terms and conditions of the warranty.

4.0 Documents to be submitted with technical offer:

(i) Documents as per PQC.

(ii) Technical datasheet of the cable with cable cross section sketch shall be submitted to BHEL/BHEL customer for approval.

Offers without the above details are liable to be rejected.

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5.0 Technical specification

(a) 3.5-cx95 sq mm Cu conductor as per IS: 8130, class 5, 1100 V grade, XLPE insulation as per IS:7098 (Part-1), Inner sheath of extruded PVC sheath ST-2 as per IS:5831, GI Flat strip armoured cable and Outer sheath of extruded FRLSH PVC ST-2 (UV-stabilised)			
1	Cable type	Flexible Annealed bare copper conductor, XLPE insulated, PVC inner sheathed, galvanised Steel flat strip armoured and overall FRLS PVC sheathed LT cable.	**Vendor reply**
2	Applicable standards	IS:7098-1/88,IS:8130/84, IS:5831/84,IS:3975	
3	Voltage grade	1100 V	
4	No of cores	3.5 cores	
5	**Conductor**		
(a)	Material	Stranded Annealed bare copper conductor Conforming to IS:8130/84	
(b)	Area(Main & reduced)	95 / 50 sq mm	
(c)	No of strands	As per class-5 of IS:8130/84	
(d)	Shape	Flexible and circular	
6	**Insulation**		
(a)	Material	XLPE Compound Confirming to IS:7098-1/88	
(b)	Type	Extruded	
(c)	Thickness (Nominal)(Main/ Reduced core)	1.1/1.0 mm	
(d)	Core identification	Red, Yellow, Blue & Reduced core Black	
7	**Inner sheath**		
(a)	Material	PVC Compound Type ST-2 Conforming to IS:5831/84	
(b)	Type	Extruded	
(c)	Thickness (Min)	0.5 mm	
(d)	Colour	Black	
8	**Armour**		
(a)	Material	Galvanised Steel Flat Strip Conf. to IS:3975	
(b)	Type	Single layer	

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(c)	Size of armour (Nominal)	4x0.8mm	
9	**Outer sheath**		
(a)	Material	PVC Compound Type ST-2 conforming to IS:5831/84 with FRLS properties	
(b)	Type	Extruded	
(c)	Thickness (Min)	1.88 mm	
(d)	Colour of outer sheath	Black	
(e)	Overall diameter	43.4 mm	
(f)	Tolerance on overall diameter	+/- 3 mm	
(g)	Marking on outer sheath	Manufacturer name, Year of manufacture, No of core x cross-sectional area, 1100V, FRLS, sequential length on outer cable sheath at every metre	
10 (a)	Drum length	Less or equal 500 m / 1000 m	
(b)	Tolerance on drum length	+/- 5%	
11	**Electrical parameters**		
(a)	Max DC resistance at 20 deg C (Main/core)	0.780 ohm per Km /0.1.21 ohm per Km	
(b)	HV test	3 kV rms for 5 minutes	
(c)	Min volume resistivity	1 x 10^{14} ohm-cm at 27^0C and 1 x 10^{12} ohm-cm at 90^0C	
12	**FRLS properties (Outer sheath)**		
(a)	Min oxygen index as per ASTMD-2863	29%	
(b)	Min temp index as per ASTMD-2863	250^0C	
(c)	Max HCL emission as per IEC-754-1	20% by weight	
(d)	Max smoke density rating as per ASTMD-2843	60%	
(e)	Flammability test on completed cable	Shall meet as per test requirement as per IEC 60332-1-2	

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(b) 4-cx25 sq mm Cu conductor as per IS: 8130, class 5, 1100 V grade, XLPE insulation as per IS:7098 (Part-1), Inner sheath of extruded PVC sheath ST-2 as per IS:5831, GI Flat strip armoured cable and Outer sheath of extruded FRLSH PVC ST-2 (UV-stabilized)			
1	Cable type	Flexible Annealed bare copper conductor, XLPE insulated, PVC inner sheathed, galvanised Steel flat strip armoured and overall FRLS PVC sheathed LT cable.	
2	Applicable standards	General conformance to IS:1554-1/88, IS:8130/84, IS:3975,	
3	Voltage grade	1100 V	
4	No of cores	4 cores	
5	**Conductor**		
(a)	Material	Stranded Annealed bare copper conductor Conforming to IS:8130/84	
(b)	Area (Main and reduced)	25 sq mm for main	
(c)	No of strands	As per class-5 of IS:8130/84	
(d)	Shape	Flexible and circular	
6	**Insulation**		
(a)	Material	PVC type-A compound, conformance to IS:-2831/84	
(b)	Type	Extruded	
(c)	Thickness (Nom) - Main/ Reduced core	0.9 mm for main core	
(d)	Core identification	Red, Yellow, Blue & Black	
7	**Inner sheath**		
(a)	Material	PVC Compound Type ST-1 Conforming to IS:5831/84	
(b)	Type	Extruded	
(c)	Thickness (Min)	0.3 mm	
(d)	Colour	Black	
8	**Armour**		
(a)	Material	Galvanised Steel Flat Strip conforming to IS:3975	
(b)	Type	Single layer	
(c)	Size of armour (Nom)	4 x 0.8 mm	
9	**Outer sheath**		

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(a)	Material	PVC Compound Type ST-2 Conforming to IS:5831/84 with FRLS properties	
(b)	Type	Extruded	
(c)	Thickness (Min)	1.4 mm	
(d)	Colour of outer sheath	Black	
(e)	Overall diameter	27.1 mm	
(f)	Tolerance on overall diameter	+/- 2 mm	
(g)	Marking on outer sheath	Manufacturer name, Year of manufacture, No of cores, cross-sectional area, 1100V, FRLS, sequential length on outer cable sheath at every meter	
10 (a)	Drum length	Less 1000 m	
(b)	Tolerance on drum length	+/- 5%	
11	**Electrical parameters**		
(a)	Max DC resistance at 20 deg C (Main/core)	0.78 ohm / Km for Main core	
(b)	HV test	3 kV rms for 5 minutes	
(c)	Min volume resistivity	1×10^{13} ohm-cm at 27^0C and 1×10^{10} ohm-cm at 70^0C	
12	**FRLS properties (Outer sheath)**		
(a)	Min oxygen index as per ASTMD-2863	29%	
(b)	Min temp index as per ASTMD-2863	250^0C	
(c)	Max HCL emission as per IEC-754-1	20% by weight	
(d)	Max smoke density rating as per ASTMD-2843	60%	
(e)	Flammability test on completed cable	Shall meet as per test requirement as per IEC 60332-1-2	

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(c) 4-cx2.5 sq mm Cu conductor as per IS: 8130, class 5, 1100 V grade, PVC insulated, PVC inner sheathed, galvanized round wire armoured and overall FRLS PVC sheathed cable			
1	Cable type	Flexible annealed bare copper conductor, PVC insulated, PVC inner sheathed, galvanised steel round wire armoured and overall FRLS PVC sheathed cable.	
2	Applicable standards	IS:1554-1/88,IS:8130/84, IS:5831/84, IS:3975	
3	Voltage grade	1100 V	
4	No of cores	4 cores	
5	**Conductor**		
(a)	Material	Stranded Annealed bare copper conductor conforming to IS:8130/84	
(b)	Size (Main and reduced)	2.5 sq mm	
(c)	No of strands	As per class-5 of IS:8130/84	
(d)	Shape	Flexible and circular	
6	**Insulation**		
(a)	Material	PVC type-A compound, conforming to IS:-5831/84	
(b)	Type	Extruded	
(c)	Thickness (Nominal)(Main/ Reduced core)	0.9	
(d)	Core identification	Red, yellow, blue and black	
7	Inner sheath		
(a)	Material	PVC Compound Type ST-1 Conforming to IS:5831/84	
(b)	Type	Extruded	
(c)	Thickness (Min)	0.3 mm	
(d)	Colour	Black	
8	ARMOUR		
(a)	Material	Galvanised steel round wire, conforming to IS:3975	
(b)	Type	Single layer	

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©	Size of armour (Nom)	1.4 mm	
9	Outer sheath		
(a)	Material	PVC compound type ST1, conforming to IS:5831/84 with FRLS properties	
(b)	Type	Extruded	
(c)	Thickness (Min)	1.24 mm	
(d)	Colour	Black	
(e)	Overall dia approx	16.4 mm	
(f)	Tolerance on overall diameter	+/- 2 mm	
(g)	Making of outer sheath	Manufacturer, Year of manufacture, No of core x cross-sectional area, 1100V, FRLS, sequential length on outer cable sheath at every metre	
8	Drum length	Less 1000 m	
(b)	Tolerance on drum length	+/- 5%	
9	**Electrical parameters**		
(a)	Max DC resistance at 20 deg C (Main/core)	7.98 ohms per Km	
(b)	HV test	3 kV rms for 5 minutes	
(c)	Min volume resistivity	1 x 10^{13} ohm-cm at 27^0C and 1 x 10^{10} ohm-cm at 70^0C	
10	**FRLS properties (Outer sheath)**		
(a)	Min oxygen index as per ASTMD-2863	29%	
(b)	Min temp index as per ASTMD-2863	250^0C	
(c)	Max HCL emission as per IEC-754-1	20% by weight	
(d)	Max smoke density rating as per ASTMD-2843	60%	
(e)	Flammability test on completed cable	Shall meet as per test requirement as per IEC 60332-1-2	

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(d) 1c x25 sq mm Cu conductor, PVC insulated and overall FRLS-PVC sheathed unarmoured cable			
1	Cable type	Flexible Annealed bare copper conductor, PVC insulated, overall FRLS PVC sheathed and unarmoured cable.	
2	Applicable standards	IS:1554-1/88,IS:8130/84,IS:5831/84	
3	Voltage grade	1100 V	
4	No of cores	1 core	
5	**Conductor**		
(a)	Material	Stranded Annealed bare copper conductor Conforming to IS:8130/84	
(b)	Size (Main and reduced)	25 sq mm	
(c)	No of strands	As per class-5 of IS:8130/84	
(d)	Shape	Flexible and circular	
6	**Insulation**		
(a)	Material	PVC Type-A Compound Confirming to IS:5831/84	
(b)	Type	Extruded	
(c)	Thickness (Nominal)(Main/ Reduced core)	1.2	
(d)	Core identification	Black	
7	**Outer sheath**		
(a)	Material	PVC compound ST-1, conforming to IS:5831/84 with FRLS properties	
(b)	Type	Extruded	
(c)	Thickness (Min)	1.8 mm	
(d)	Colour	Black	
(e)	Overall diameter	13.5 mm	
(f)	Tolerance on overall diameter	+/- 2 mm	
(g)	Marking on outer sheath	Manufacturer name, Year of manufacture, No of core x cross-sectional area, 1100V, FRLS, sequential length on outer cable sheath at every metre	
10 (a)	Drum length	Less or equal 500 m / 1000 m	

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(b)	Tolerance on drum length	+/- 5%	
11	**Electrical parameters**		
(a)	Max DC resistance at 20 deg C (Main/core)	0.780 ohm per Km	
(b)	HV test	3 kV rms for 5 minutes	
(c)	Min volume resistivity	1 x 10^{13} ohm-cm at 27^0C and 1 x 10^{10} ohm-cm at 70^0C	
12	**FRLS properties (Outer sheath)**		
(a)	Min oxygen index as per ASTMD-2863	29%	
(b)	Min temp index as per ASTMD-2863	250^0C	
(c)	Max HCL emission as per IEC-754-1	20% by weight	
(d)	Max smoke density rating as per ASTMD-2843	60%	
(e)	Flammability test on completed cable	Shall meet as per test requirement as per IEC 60332-1-2	

(e)) 1c x1.5 sq mm Cu conductor, PVC insulated cable			
1	Cable type	Flexible Annealed bare copper conductor, PVC insulated, and unarmoured cable.	
2	Applicable standards	IS:1554-1/88,IS:8130/84, IS:5831/84	
3	Voltage grade	1100 V	
4	No of cores	1 core	
5	**Conductor**		
(a)	Material	Stranded Annealed bare copper conductor Conforming to IS:8130/84	
(b)	Size (Main and reduced)	1.5 sq mm	
(c)	No of strands	As per class-5 of IS:8130/84	
(d)	Shape	Flexible and circular	
6	**Insulation**		
(a)	Material	PVC type-A compound conforming to IS:5831/84	
(b)	Type	Extruded	

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(c)	Thickness (Nominal)(Main/ Reduced core)	0.8 mm	
(d)	Core identification	Black	
(e)	Overall diameter	To be mentioned	
(f)	Tolerance on overall diameter	To be mentioned	
(g)	Marking on outer sheath	To be mentioned	
10 (a)	Drum length	Less or equal 500 m / 1000 m	
(b)	Tolerance on drum length	+/- 5%	
11	**Electrical parameters**		
(a)	Max DC resistance at 20 deg C (Main/core)	13.3 ohms per Km	
(b)	HV test	3 kV rms for 5 minutes	
(c)	Min volume resistivity	1 x 10^{13} ohm-cm at 27^0C and 1 x 10^{10} ohm-cm at 90^0C	

(f)) 2c x 1.5 sq mm copper PC insulated, PVC inner sheathed and overall FRLS PVC sheathed unarmoured cable			
1	Cable type	Flexible annealed bare copper conductor, PVC insulated, PVC inner sheathed and overall FRLS-PVC sheathed unarm cable	
2	Applicable standards	IS:1554-1/88,IS:8130/84, IS:5831/84, others to be mentioned	
3	Voltage grade	1100 V	
4	No of cores	2 cores	
5	**Conductor**		
(a)	Material	Stranded Annealed bare copper conductor Conforming to IS:8130/84	
(b)	Size	1.5 sq mm, each core	
(c)	No of strands	As per class-5 of IS:8130/84	
(d)	Shape	Flexible and circular	
6	**Insulation**		

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(a)	Material	PVC type-A compound conforming to IS:5831/84	
(b)	Type	Extruded	
(c)	Thickness (Nominal)(Main/ Reduced core)	0.8 mm	
(d)	Core identification	Red and Black	
7	Inner sheath		
(a)	Material	PVC compound ST-1, conforming to IS:5831/84	
(b)	Type	Extruded	
(c)	Thickness (Nominal)(Main/ Reduced core)	0.3 mm	
(d)	Colour	Black	
10	Outer sheath		
(a)	Material	PVC compound ST-1, conforming to IS:5831/84 with FRLS properties	
(b)	Type	Extruded	
(c)	Thickness (Nom)	1.8 mm	
(d)	Colour of outer sheath	Black	
(e)	Overall diameter	To be mentioned	
(f)	Tolerance on overall diameter	To be mentioned	
(g)	Marking on outer sheath	To be mentioned	
10 (a)	Drum length	Less or equal 500 m / 1000 m	
(b)	Tolerance on drum length	+/- 5%	
11	**Electrical parameters**		
(a)	Max DC resistance at 20 deg C (Main/core)	13.3 ohms per Km	
(b)	HV test	3 kV rms for 5 minutes	
(c)	Min volume resistivity	1×10^{13} ohm-cm at 27^0C and 1×10^{10} ohm-cm at 90^0C	
12	**FRLS properties (Outer sheath)**		
(a)	Min oxygen index as per ASTMD-2863	29%	
(b)	Min temp index as per ASTMD-2863	250^0C	

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(c)	Max HCL emission as per IEC-754-1	20% by weight	
(d)	Max smoke density rating as per ASTMD-2843	60%	
(e)	Flammability test on completed cable	Shall meet as per test requirement as per IEC 60332-1-2	

(g) **12-core x 1.5 sq mm** copper conductor, PVC insulated, overall screened and overall FRLS-PVC sheathed unarmoured cable			
1	Cable type	Flexible Annealed bare copper conductor, PVC insulated, Overall screened and overall FRLS PVC outer sheathed unarmoured instrumentation cable	
2	Applicable standards	IS:5038-2/86,IS:8130/84,	
3	Voltage grade	300/500 volts	
4	No of cores	12 cores	
5	**Conductor**		
(a)	Material	Stranded Annealed bare copper conductor Conforming to IS:8130/84	
(b)	Size	1.50 sq mm	
(c)	No of strands	As per class-5 of IS:8130/84	
(d)	Shape	Flexible and circular	
6	**Insulation**		
(a)	Material	PVC Type-A, conforming to IS:5831/84	
(b)	Type	Extruded	
(c)	Thickness (Nominal)(Main/ Reduced core)	0.6	
(d)	Core identification	All crores shall be grey, **also numbering shall be provided on each core for core identification.**	
7	**Overall shielding**		
(a)	Material	Aluminum-Mylar Tape	
(b)	Type	Helical	
(c)	Thickness (Min)	0.018 mm	
(d)	Overlap/coverage	25/100	
8	**Drain Wire**		

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(a)	Material	Stranded Annealed Tinned Copper	
(b)	size	$0.5mm^2$	
(c)	No. of strands	7	
9	**Outer sheath**		
(a)	Material	PVC Compound Type ST-1 Conforming to IS:5831/84	
(b)	Type	Extruded	
(c)	Thickness (Min)	1.2 mm	
(d)	Colour of outer sheath	Black	
(e)	Overall diameter	14.9 mm or to be mentioned if otherwise	
(f)	Tolerance on overall diameter	+/- 2 mm	
(g)	Marking on outer sheath	Manufacturer name, Year of manufacture, No of core x cross-sectional area, 300/500 V, FRLS, sequential length on outer cable sheath at every meter	
10 (a)	**Drum length**	Less or equal 500 m / 1000 m	
(b)	Tolerance on drum length	+/- 5%	
11	**Electrical parameters**		
(a)	Max DC resistance at 20^0C (Main/core)	13.3	
(b)	Min insulation resistance of completed cable at 20^0C	25 Mohms	
(c)	Max mutual capacitance between any core & screen at 1 KHz	250 pF/ metre	
(d)	Max capacitance between any core & screen at 1 KHz	450 pF/ metre	
(e)	High voltage test	1 kV rms for 1 minute	
12	**FRLS properties (Outer sheath)**		
(a)	Min oxygen index as per ASTMD-2863	29%	
(b)	Min temp index as per ASTMD-2863	250^0C	

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(c)	Max HCL emission as per IEC-754-1	20% by weight	
(d)	Max smoke density rating as per ASTMD-2843	60%	
(e)	Flammability test on completed cable	Shall meet as per test requirement as per IEC 60332-1-2	

(h) 2-pair x 4 sq mm copper conductor, PVC insulated, overall screened and overall FRLS-PVC sheathed instrumentation cable			
1	Cable type	2-pair copper conductor, PVC insulated, Overall screened and overall FRLS PVC sheathed unarmoured instrumentation cable.	
2	Applicable standards	IS:5308-2/86,IS:8130/84, IS:5831/84	
3	Voltage grade	300/500 V	
4	No of Pair	2P	
5	**Conductor**		
(a)	Material	Stranded Annealed bare copper conductor conforming to IS:8130/84	
(b)	Size	4 sq mm	
(c)	No of strands	As per class-5 of IS:8130/84	
(d)	Shape	Flexible and circular	
6	**Insulation**		
(a)	Material	PVC Type-A conforming to IS:5831/84	
(b)	Type	Extruded	
(c)	Thickness (Nominal)(Main/ Reduced core)	0.8 mm	
(d)	Pair identification	All pair shall be white, blue, also Cores of each pair shall be numbered for pair identification	
(f)	Approx. number of Twist(for cores in pair)	10 twists/meter	
7	**Overall Shielding**		
(a)	Material	Aluminum-Mylar Tape	
(b)	Type	Helical	
(c)	Thickness (Min)	0.018 mm	
(d)	Overlap/coverage	25/100%	
8	**Drain Wire (for overall**		

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	screening)		
(a)	Material	Annealed Tinned copper	
(b)	Size	0.5 sq mm	
(c)	No. of strands / approx dia of each strand	7 strands / 0.3 mm	
9	**Outer sheath**		
(a)	Material	PVC Compound Type ST-1 Conforming to IS:5831/84 with FRLS properties	
(b)	Type	Extruded	
(c)	Thickness (Min)	1.3 mm	
(d)	Colour of outer sheath	Black	
(e)	Overall diameter	17.2 mm	
(f)	Tolerance on overall diameter	+/- 2 mm	
(g)	Marking on outer sheath	Manufacturer name, Year of manufacture, No of core x cross-sectional area, 1100V, FRLS, sequential length on outer cable sheath at every meter	
10	**Drum length**	Less or equal 500 m / 1000 m	
	Tolerance on drum length	+/- 5%	
11	**Electrical parameters**		
(a)	Max DC resistance at 20^0C (Main/core)	4.95 ohms per Km	
(b)	Min. insulation resistance of complete cable at 20^0C	25 Mohms per Km	
(c)	Max. Mutual capacitance between pairs or adjacent cores at 1 KHz	250 pF per meter	
(d)	Max. capacitance between core and screen at 1 KHz	450 pF per meter	
(e)	HV test	2 kV rms for 1 minute	
12	**FRLS properties (Outer sheath)**		
(a)	Min oxygen index as per ASTMD-2863	29%	

(b)	Min temp index as per ASTMD-2863	250^0C	
(c)	Max HCL emission as per IEC-754-1	20% by weight	
(e)	Flammability test on completed cable	Shall meet as per test requirement as per IEC 60332-1-2	

7.0 Documents to be submitted within 1 week after receipt of Purchase order

1. Technical datasheet of the cable with cable cross section sketch shall be submitted to BHEL/BHEL customer for approval.
2. Manufacturing Quality Plan (MQP) indicating all tests/checks regarding raw material, in-process and final product as per relevant IS/IEC standards, as called in this document and any other relevant standards shall be submitted to BHEL/BHEL customer for approval.

8.0 Inspection and testing of transformers at vendor works:

(i) BHEL and BHEL customer shall witness the testing of the cables as per relevant standard.

(ii) **Routine and acceptance tests**

Vendor shall submit routine and acceptance test plan for approval by BHEL / BHEL customer.

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