



BHARAT HEAVY ELECTRICALS LIMITED

TRANSMISSION BUSINESS ENGINEERING MANAGEMENT

DOCUMENT No.	TB 350 510 020B	Rev 00	Prepared	Checked	Approved
TYPE OF DOC.	TECHNICAL SPECIFICATION	NAME	RD	VK	VK
TITLE 1.1 kV Aux Power & Control Cables		SIGN			
		DATE			
		GROUP	TBEM	W.O. No	81004
CUSTOMER	NABINAGAR POWER GENERATING CO. PVT. LIMITED (NPGC) (A Joint Venture of NTPC Ltd. And Bihar State Electricity Board)				
CONSULTANT	----				
PROJECT	400/132 KV SWITCHYARD PACKAGE AT NABINAGAR SUPER THERMAL POWER PROJECT (3 X 660 MW)				

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5.	Checklist (To be furnished at Tender Stage)	04

Rev No.	Date	Altered	Checked	Approved	REVISION DETAILS
Distribution			To Copies	TBTS O/C TBMM TBQM TBCM	
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**Project: 400/132 kV Switchyard Package at
Nabinagar Super Thermal Power Project (3 X 660 MW)
Customer: Nabinagar Power Generating Co. Pvt.
Limited (NPGC)
Consultant: -----
Technical Specification: 1.1 kV Aux Power & Control Cables**

**Bharat Heavy Electricals Limited
Document No. TB 350 510 020B**

SECTION 1

SCOPE, SPECIFIC TECHNICAL REQUIREMENTS AND QUANTITIES

1.0 SCOPE

This Specification covers the requirements of design, manufacture, testing at manufacturer's Works, packing, supply, delivery at site of 1.1 kV Aux Power & Control Cables as listed under this specification. This section covers the specific technical requirements of 1.1 kV Aux Power & Control Cables. This constitutes minimum technical parameters for the above item as specified by the customer (NPGC). The offered equipment shall also comply with the General Specification for the project as detailed under section-3 of this specification.

In case of any conflict between the technical details mentioned in this section and the remaining sections of this document, then Section-1 shall prevail and is to be considered as binding requirement.

The specification comprise of following sections:

- Section-1: Scope, Specific Technical Requirements and Quantities.
- Section-2: Equipment Specification.
- Section-3: Project Details and General Technical Requirements.
- Section-4: Guaranteed Technical Particulars.
- Section-5: Checklist.

Note: The term 'Owner' appearing in this specification shall refer to NPGC, the term 'Purchaser' shall refer to BHEL and the term 'Contractor' shall refer to the successful Bidder.

1.1 THE EQUIPMENT IS REQUIRED FOR THE FOLLOWING PROJECT

Name of customer: Nabinagar Power Generating Co. Pvt. Limited (NPGC)
(A Joint Venture of NTPC Ltd. And Bihar State Electricity Board)

Name of Consultant: -----

Name of of the project: 400/132 kV Switchyard Package at Nabinagar Super Thermal Power Project (3 X 660 MW)

Refer Section - 3 for Project Details and General Specifications.

**Project: 400/132 kV Switchyard Package at
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1.2 SPECIFIC TECHNICAL REQUIREMENTS

- 1.2.1** As per Annexure-1A (NPGC specification, 3 pages) and Annexure-1B (NPGC specification, 10 pages).
- 1.2.2** (a) Strip armouring method (a) mentioned in Table 5, Page-6 of IS: 1554 (Part 1) - 1988 shall not be accepted for any of the cables.
(b) Strip armouring method (a) mentioned in Table 6, Page-6 of IS: 7098 (Part 1) - 1988 shall not be accepted for any of the cables.

1.3 QUANTITIES

Sl. No.	Type of Control Cables	Quantity (kM)		
		400/132 kV Switchyard at Nabinagar STPP	400 kV Bay Extension at Nabinagar TPP	Total
1.1	2C x 2.5 sq mm PVC/Copper, Armoured	0	0	0
1.2	5C x 2.5 sq mm PVC/Copper, Armoured	16.0	0	16.0
1.3	10C x 2.5sqmm PVC/Copper, Armoured	24.0	0	24.0
1.4	14C x 2.5 sq mm PVC/Copper, Armoured	3.0	0	3.0
1.5	19C x 2.5 sq mm PVC/Copper, Armoured	6.0	0	6.0
1.6	4C x 10 sq mm PVC/Copper, Armoured	1.0	0	1.0
	Type of Aux Power Cables			
2.1	2C x 6 sq mm PVC/Aluminium, Armoured	0	0	0
2.2	4C x 6 sq mm PVC/Aluminium, Armoured	0	0	0
2.3	4C x 16 sq mm PVC/Aluminium, Armoured	0	0	0
2.4	3.5C x 70 sq mm PVC/Aluminium, Armoured	0	0	0
2.5	3.5C x 150 sq mm XLPE/Aluminium, Armoured	0	0	0
* 2.6	3.5C x 300 sq mm XLPE/Aluminium, Armoured	0	0	0
2.7	2C x 150 sq mm XLPE/Aluminium, Armoured	0	0	0
* 2.8	1C x 630 sq mm XLPE/Aluminium, Armoured	0	0	0
	Type of Screened Control Cables			
3.1	4P x 0.5 sq mm PVC/Copper, Armoured	0	0	0

Note:

1) Quantity variation on the total ordered cables shall be $\pm 30\%$ at contract stage.

2) Cable types mentioned in Sl. No. 1.5, 2.3 above may not be required at all.

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Technical Specification: 1.1 kV Aux Power & Control Cables

3) Cut lengths for cables marked as (*) shall be informed during detailed engineering stage.

All Control and Power Cables shall be supplied in drum length of 1000 m, unless otherwise specified. For power cable with conductor cross sectional area 300sqmm and above may be supplied in 500m drums. Owner shall have the option of rejecting cable drums with shorter lengths. The cable length per drum is allowed a tolerance of $\pm 5\%$. However, the total quantity of cables after taking into consideration of all cable drums for each size shall be within the tolerance of $\pm 2\%$.

1.4 TESTS

Cables shall conform to type tests including additional type tests as per technical specification and shall be subject to routine & acceptance tests in accordance with requirements stipulated under respective sections.

The reports for all type tests and additional type tests as per technical specification shall be furnished by the bidder along with equipment / material drawings.

The bidder will conduct the routine tests on each drum length. All the type and acceptance tests shall be conducted as per specification and relevant standards/ approved MQP. These tests will be witnessed by owner/purchaser/purchaser's representatives.

The prices for conducting all tests are deemed to be included in respective cable prices.

1.5 QUALITY PLAN

The manufacturer shall carry out contract works in accordance with sound quality management principles which shall include items such as controls which are necessary to ensure full compliance to all requirements of the specification & applicable international standards. These quality management requirement shall apply to all activities during design, procurement, manufacturing, inspection, testing, packaging, shipping, inland transportation, storage, site erection & commissioning. Manufacturer shall submit detailed Quality Plan for BHEL / customer's approval.

ANNEXURE - 1A

Clause No.

TECHNICAL REQUIREMENTS



CHAPTER- E11: LT POWER AND CONTROL CABLES

1.00.00

CODES AND STANDARDS

Cables IS:1554, IS:7098, IS:502, IS:6380, IS:9968

2.00.00

GENERAL REQUIREMENTS

2.01.00

All cables shall be suitable for high ambient, high humid tropical Indian climatic conditions. All cables shall be Flame Retardant Low Smoke (FRLS) type designed to withstand the mechanical, electrical and thermal stresses under the foreseen steady state and transient/fault conditions, and shall be suitable for the proposed method of installation.

2.02.00

The aluminium/copper wires used for manufacturing the cables shall be true circular in shape before stranding and shall be of uniformly good quality, free from defects. All aluminium used in the cables shall be of H2 grade.

2.03.00

The fillers and inner sheath shall be of non hygroscopic, fire retarding material, softer than insulation and outer sheath shall be suitable for the temperature of the cable.

2.04.00

For cables having more than five (5) cores, each core shall be identified by number marking. However, for cables upto five (5) cores, the same shall be by colour.

2.05.00

The normal current rating of all the PVC insulated cables shall be as per IS 5831.

2.06.00

All the cables used in the switchyard shall be armoured. All the lugs and glands as required are deemed to be included in the cost of cables.

2.07.00

Other parameters of the cables are as follows:

Particulars	Power cables	Control cables
	XLPE	PVC
Conductor		
i) Material	Stranded Aluminium	Stranded plain annealed copper
ii) Size	As required Min. 6 sq.mm size	As required, but min. 1.5 sq.mm. size
iii) Shape	Circular / sector shaped	Circular / sector shaped

NABINAGAR STPP (3X660MW)
400/132kV SWITCHYARD
PACKAGE

Bid DOC. NO:
CS-0370-572-2

TECHNICAL
SPECIFICATIONS

PART-II
SECTION-VI

Page
E11- 1 of 3

Clause No.	TECHNICAL REQUIREMENTS					
	<u>Particulars</u>	<u>Power cables</u>		<u>Control cables</u>		
		<u>XLPE</u>	<u>PVC</u>			
	Main Insulation					
	i) Material	XLPE	PVC	PVC		
	ii) Continuous withstand temperature (deg.C)	90	70	70		
	iii) Short circuit withstand temperature (deg.C)	250	160	160		
	iv) Colour identification	As per relevant codes and standards				
	Inner Sheath	All armoured and multicore unarmoured cables have distinct extruded inner sheath				
	i) Material	PVC	PVC	PVC		
	ii) Colour	Black	Black	Black		
	Armour					
	i) Material	Aluminium wire for single core cable and GS wire/flat for multi-core cables as per Relevant IS. Minimum Coverage of 90%	GS wire/flat as per relevant IS. Min. coverage of 90%			
	ii) Breaking load of joint	95% of normal armour	95% of normal armour			
	Outer sheath					
	i) Material (Polyethylene based halogen free material not acceptable)	PVC	PVC	PVC	Heat resistant	
	ii) Colour	Black	Black	Grey		
	iii) Marking	- Cable size & voltage grade (by embossing) - Word "FRLS" @ 5m (by embossing) - Sequential marking @1m			Same as for Power cables	
NABINAGAR STPP (3X660MW) 400/132kV SWITCHYARD PACKAGE						
Bid DOC. NO: CS-0370-572-2		TECHNICAL SPECIFICATIONS		PART-II SECTION-VI		
Page E11- 2 of 3						

Clause No.	TECHNICAL REQUIREMENTS				
	FRLS properties on outer sheath	Oxygen Index : Min. 29 (As per ASTM D 2863) Acid gas generation : Max. 20% (As per IEC 754-1) Smoke density rating : 60% (As per ASTM D 2843)			
	Flamability test on all types of cables	As per Swedish chimney test F3 as per SEN 4241475 As per IEC 332 Part-3 (Category B)			
3.00.00	Testing:				
3.01.00	All cables shall conform to type test and shall be subjected to routine and acceptance tests as per relevant IS. The cables shall be tested for oxygen index, temperature index and fire resistance test.				

CLAUSE NO.	TECHNICAL REQUIREMENTS		
1.02.12	sheath, 1100 V grade and conform to IS 1554 Part I.		
1.02.13	Installation of all required temporary construction power wiring, receptacles & lighting.		
1.02.13	Wherever the quantity has been defined as on as required basis, the same are to be furnished by Contractor on as required basis within his quoted lumpsum price without any further cost implication to the Employer.		
2.00.00	SPECIFICATION OF INSTRUMENTATION CABLE		
2.01.00	Common Requirements		
	S. No.	Property	Requirement
	1	Voltage grade	225 V (peak value) 1.1kV
	2.	Codes and standard	All instrumentation cables shall comply with VDE 0815, VDE 0207, Part 4, Part 5, Part 6, VDE 0816, VDE 0472, SEN 4241475, ANSI MC 96.1, IS-8784, IS-10810 (latest editions) and their amendments read along with this specification.
	3.	Continuous operation suitability	At 70 deg. C for all types of cables, while 205 Deg C for Type-C cables.
	4.	Progressive automatic on-line sequential marking of length in meters	To be provided at every one meter on outer sheath.
	5.	Marking to read 'FRLS'	To be provided at every 5 meters on outer sheath except for Type-C cable.
	6.	Allowable Tolerance on overall diameter	+/- 2 mm (maximum) over the declared value in data sheet
	7.	Variation in diameter	Not more than 1.0 mm throughout the length of cable.
	8	Ovality at any cross-section	Not more than 1.0 mm
	9	Others	a) Durable marking at intervals not exceeding 625 mm shall include manufacturer's name, insulation material, conductor's size, number of pairs, voltage rating, type of cable, year of manufacturer to be provided. b) Cables shall be suitable for laying
I	TECHNICAL SPECIFICATION SECTION - VI PART-B		IIIC-06 INSTRUMENTATION & POWER SUPPLY CABLE PAGE 4 OF 18

CLAUSE NO.	TECHNICAL REQUIREMENTS				
2.02.00	S. No.	Property		Requirement	
				in conduits, ducts, trenches, racks and underground-buried installation c) Repaired cables shall not be acceptable.	
	Specific Requirements				
	Specification Requirements	Type-A cable	Type-B cable	Type F & G cable	Type-C cable
	A. Conductors				
	Cross section area	0.5 sq. mm			
	Conductor material	ANSI type KX	ANSI type SX	High conductivity Annealed bare copper	ANSI type KX
	Colour code	Yellow-Red	Black-Red	As per VDE-815	Yellow-Red
	Conductor Grade	As per ANSI MC 96.1		Electrolytic	As per ANSI MC 96.1
	No & dia of strands	7x0.3 mm (nom)			
	No. of Pairs	2	2	4,8,12,16,24,48	2
	Max. conductor resistance per Km (in ohm) at 20 deg. C	As per ANSI MC 96.1		73.4 (loop)	As per ANSI MC 96.1
	Reference Standard	As per ANSI MC 96.1		VDE 0815	As per ANSI MC 96.1
	B. Insulation				
	Material	PVC type YI 3			Teflon (i.e. extruded FEP)
	Thickness in mm (Min/Nom/Max)	0.25/0.3/0.35 Thickness for 1.1kV Voltage class as per relevant standard			0.4/0.50
		TECHNICAL SPECIFICATION SECTION - VI PART-B	IIIC-06 INSTRUMENTATION & POWER SUPPLY CABLE	PAGE 5 OF 18	

CLAUSE NO.	TECHNICAL REQUIREMENTS				
	Volume Resistivity (Min) in ohm-cm	1 x 10 ¹⁴ at 20 deg. C & 1x10 ¹¹ at 70 deg. C.		---	
	Voltage Rating	1.1kV peak operating voltage			
	Reference Standard	VDE 0207 Part 4		VDE 0207 Part 6 & ASTM D 2116.	
	Core diameter above insulation	Suitable for cage clamp connector			
	C. Pairing & Twisting				
	Max. lay of pairs (mm)	50			
	Single layer of Numbered binder tape on each pair provided	Numbered Tape	Yes	Not applicable	
	Unit formation of four pairs with printing of no. of Unit provided	N.A.	Yes	N.A.	
	Conductor /pair identification as per VDE0815	N.A.	To be provided (color coding attached).	N.A.	
	D. Shielding				
	Type of shielding	Al-Mylar tape			
	Individual pair shielding	No	To be provided for F-type cable	No	
	Minimum thickness of Individual pair shielding	No	28 micron	No	
	Overall cable assembly shielding	To be provided			
	Minimum thickness of Overall cable assembly shielding	55 micron			
			TECHNICAL SPECIFICATION SECTION - VI PART-B	IIIC-06 INSTRUMENTATION & POWER SUPPLY CABLE	PAGE 6 OF 18

CLAUSE NO.	TECHNICAL REQUIREMENTS			
	Shielding coverage	100% with at least 20% overlap		
	Drain wire provided for individual shield	N.A.	Yes (for F-type) 7-strand 20 AWG (0.51 mm ²) annealed Tin coated copper	N.A.
	Drain wire provided for overall shield	Yes. 7-strand 20 AWG (0.51 mm ²) annealed Tin coated copper		
	E. FILLERS			
	Non-hygroscopic, flame retardant	To be provided		
	F. Outer Sheath			
	Material	Extruded PVC compound YM1 with FRLS properties		Teflon (i.e. extruded FEP)
	Minimum Thickness at any point	1.8 mm		0.4 mm
	Nominal Thickness at any point	>1.8 mm		0.5 mm
	Color	Blue		
	Resistant to water, fungus, termite & rodent attack	Required		
	Oxygen index as per ASTMD-2863	not less than 29%		N.A.
	Temperature index as per ASTMD-2863	not less than 250 deg.C		N.A.
	acid gas generation by weight as per IEC-60754-1	Maximum 20%		N.A.
	Smoke Density Rating as per	Maximum 60%		N.A.
			TECHNICAL SPECIFICATION SECTION - VI PART-B	IIIC-06 INSTRUMENTATION & POWER SUPPLY CABLE

CLAUSE NO.	TECHNICAL REQUIREMENTS			
	ASTMD-2843	(defined as the average area under the curve when the results of smoke density test plotted on a curve indicating light absorption vs. time as per ASTMD-2843)		
	Reference standard	VDE207 Part 5		VDE207 Part 6 & ASTM D2116
	G. Electrical Parameters			
	Mutual Capacitance Between Conductors At 0.8 KHz (Max.)	200 nF/km	120 nF/km for F type 100 nF/km for G-type	200 nF/km
	Insulation Resistance(Min.)	100 M Ohm/Km		
	Cross Talk Figure (Min.) At 0.8 KHz	60 dB	60 dB	N.A.
	Characteristic Impedance (Max) At 1 KHz	N.A.	320 OHM FOR F-TYPE 340 OHM FOR G-TYPE	N.A.
	Attenuation Figure At 1 KHz (Max)	N.A.	1.2 db/km	N.A.
	H. Complete Cable			
	Complete Cable assembly	Shall pass Swedish Chimney test as per SEN-SS 4241475 class F3.		N.A.
	Flammability	Shall pass flammability as per IEEE-383 read in conjunction to this specification		N.A.
	I. Tests			
	Routine & Acceptance tests	Refer sub section III E		
	Type tests	Refer sub section CNI TYPE TEST		
	J Cable Drum			
	Type	Non-returnable wooden drum (wooden drum to be constructed from seasoned wood free from defects with wood		
		TECHNICAL SPECIFICATION SECTION - VI PART-B	IIIC-06 INSTRUMENTATION & POWER SUPPLY CABLE	PAGE 8 OF 18

CLAUSE NO.	TECHNICAL REQUIREMENTS		
		preservative applied to the entire drum) or steel drum.	
	Outermost layer covered with waterproof paper	Yes	
	Painting	Entire surface to be painted	
	Length	1000 m $\pm$ 5% for up to & including 12 pairs 500 m $\pm$ 5% for above 12 pairs	
3.00.00	SPECIFICATION OF OPTICAL FIBER CABLES (OFC)		
3.01.00	Optic Fiber cable shall be 4/8/12 core, galvanised corrugated steel taped armoured, fully water blocked with dielectric central member for outdoor/indoor application so as to prevent any physical damage. The cable shall have multiple single mode or multi mode fibers on as required basis so as to avoid the usage of any repeaters. The core and cladding diameter shall be 9 $\pm$ 1 micrometer and 125 $\pm$ 1 micrometer respectively. The outer sheath shall have Flame Retardant, UV resistant properties and are to be identified with the manufacturer's name, year of manufacturer, progressive automatic sequential on line marking of length in meters at every meter on outer sheath.		
3.02.00	The cable core shall have suitable characteristics and strengthening for prevention of damage during pulling viz. Steel central member, Loose buffer tube design, 4 fibers per buffer tube (minimum), Interstices and buffer tubes duly filled with Thixotropic jelly etc. The cable shall be suitable for a maximum tensile force of 2000 N during installation, and once installed, a tensile force of 1000 N minimum. The compressive strength of cable shall be 3000 N minimum & crush resistance 4000 N minimum. The operating temperature shall be -20 deg. C to 70 deg. C		
3.03.00	All testing of the fiber optic cable being supplied shall be as per the relevant IEC, EIA and other international standards.		
3.04.00	Bidder to ensure that minimum 100% cores are kept as spares in all types of optical fibre cables.		
3.05.00	Cables shall be suitable for laying in conduits, ducts, trenches, racks and under ground buried installation.		
3.06.00	Spliced / Repaired cables are not acceptable.		
3.07.00	Penetration of water resistance and impact resistance shall be as per IEC standard.		
4.00.00	SPECIFICATION OF POWER SUPPLY CABLES		
	TECHNICAL SPECIFICATION SECTION - VI PART-B	IIIC-06 INSTRUMENTATION & POWER SUPPLY CABLE	PAGE 9 OF 18

CLAUSE NO.	TECHNICAL REQUIREMENTS				
3.00.00	TYPE TEST REQUIREMENT FOR C&I SYSTEMS				
Sl. No	Item	Test Requirement	Standard	Test To Be Specifically Conducted	NTPC's Approval Req. On Test Certificate
Col 1	Col 2	Col 3	Col 4	Col 5	Col 6
1	Elect. Metering instruments	As per standard (col-4)	IS 1248	No	Yes
2	Transducers	As per standard (col-4)	IEC-60688, IS12784	No	Yes
3	Thermocouple	Degree of protection test	IS-13947	No	No
4	RTD	As per standard (col-4)	IEC-60751	No	No
5	Electronic transmitter	As per standard (col-4)	BS-6447 / IEC-60770	No	Yes
6	E/P converter	As per standard (col-4)	Mfr. standard	No	Yes
7	Dust emission monitor	Degree of protection test	IS-13947	No	Yes
8	Instrumentation Cables Twisted & Shielded*				
	-Conductor	Resistance test	VDE-0815	No	Yes
		Diameter test	IS-10810	No	Yes
		Tin Coating test (Persulphate test)	IS-8130	No	Yes
	-Insulation	Loss of mass	VDE 0472	No	Yes
		Ageing in air ovens**	VDE 0472	No	Yes
		TECHNICAL SPECIFICATION SECTION - VI PART-B		IIIC-07 TYPE TEST REQUIREMENTS	PAGE 4 OF 10

CLAUSE NO.	TECHNICAL REQUIREMENTS				
		Tensile strength and elongation test before and after ageing**	VDE 0472	No	Yes
		Heat shock	VDE 0472	No	Yes
		Hot deformation	VDE 0472	No	Yes
		Shrinkage	VDE 0472	No	Yes
		Bleeding & blooming	IS-10810	No	Yes
	-Inner sheath***	Loss of mass	VDE 0472	No	Yes
		Heat shock	VDE 0472	No	Yes
		Cold bend/ cold impact test	VDE 0472	No	Yes
		Hot deformation	VDE 0472	No	Yes
		Shrinkage	VDE 0472	No	Yes
	-Outer sheath	Loss of mass	VDE 0472	No	Yes
		Ageing in air ovens**	VDE 0472	No	Yes
		Tensile strength and elongation test before and after ageing**	VDE 0472	No	Yes
		Heat shock	VDE 0472	No	Yes
		Hot deformation	VDE 0472	No	Yes
		Shrinkage	VDE 0472	No	Yes
		Bleeding & blooming	IS-10810	No	Yes
		Colour fastness to water	IS-5831	No	Yes
		TECHNICAL SPECIFICATION SECTION - VI PART-B	IIIC-07 TYPE TEST REQUIREMENTS		PAGE 5 OF 10

CLAUSE NO.	TECHNICAL REQUIREMENTS				
		Cold bend/ cold impact test	VDE-0472	No	Yes
		Oxygen index test	ASTMD- 2863	No	Yes
		Smoke Density Test	ASTMD- 2843	No	Yes
		Acid gas generation test	IEC-60754-1	No	Yes
	-fillers	Oxygen index test	ASTMD- 2863	No	Yes
		Acid gas generation test	IEC-60754-1	No	Yes
	-AL-MYLAR shield	Continuity test		No	Yes
		Shield thickness		No	Yes
		Overlap test		No	Yes
	-Over all cable	Flammability Test	IEEE 383	No	Yes
		Swedish Chimney Test	SEN 4241475	No	Yes
		Noise interference	IEEE Trans- actions	No	Yes
		Dimensional checks	IS 10810	No	Yes
		Cross talk	VDE-0472	No	Yes
		Mutual capacitance	VDE-0472	No	Yes
		HV test	VDE-0815	No	Yes
		Drain wire continuity		No	Yes
	TECHNICAL SPECIFICATION SECTION - VI PART-B		IIC-07 TYPE TEST REQUIREMENTS		PAGE 6 OF 10

CLAUSE NO.	TECHNICAL REQUIREMENTS																												
	* 1.0 All cables to be supplied shall be of type tested quality. The Contractor shall submit for Owner's approval the reports of all the type tests as listed in this specification and carried out within last five years from the date of bid opening. These reports should be for the tests conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client. 2.0 In case the Contractor is not able to submit report of the type test(s) conducted within last five years from the date of bid opening, or in case the type test report(s) are not found to be meeting the specification requirements, the Contractor shall conduct all such tests under this contract free of cost to the Owner and submit the reports for approval. **These tests shall be carried out as per VDE0207 Part 6 & ASTM-D-2116 for TEFLON insulated & outer sheathed cables ***Applicable for armoured cables only 9 DC Power Supply System (Applicable for each model and rating) 1) The Type Test reports for offered rectifier module and the controller module irrespective of the rectifier bank rating shall be acceptable. <table><tr><td>Surge withstand Capability (SWC)</td><td>ANSI 37-90.1 IEEE 472, EN 61000-4-12</td><td>Yes</td><td>Yes</td></tr><tr><td>Dry Test</td><td>Heat IEC 68-2-2 or equivalent</td><td>No</td><td>Yes</td></tr><tr><td>Damp test</td><td>Heat IEC 68-2-2 or equivalent</td><td>No</td><td>Yes</td></tr><tr><td>Vibration test</td><td>IEC 68-2-2 or equivalent</td><td>No</td><td>Yes</td></tr><tr><td>Electrostatic discharge test</td><td>EN 61000-4-2 or equivalent</td><td>No</td><td>Yes</td></tr><tr><td>Radio frequency immunity test</td><td>EN 61000-4-3 or equivalent</td><td>No</td><td>Yes</td></tr><tr><td>Electromagnetic field immunity</td><td>EN 61000-4-3 or equivalent</td><td>No</td><td>Yes</td></tr></table>	Surge withstand Capability (SWC)	ANSI 37-90.1 IEEE 472, EN 61000-4-12	Yes	Yes	Dry Test	Heat IEC 68-2-2 or equivalent	No	Yes	Damp test	Heat IEC 68-2-2 or equivalent	No	Yes	Vibration test	IEC 68-2-2 or equivalent	No	Yes	Electrostatic discharge test	EN 61000-4-2 or equivalent	No	Yes	Radio frequency immunity test	EN 61000-4-3 or equivalent	No	Yes	Electromagnetic field immunity	EN 61000-4-3 or equivalent	No	Yes
Surge withstand Capability (SWC)	ANSI 37-90.1 IEEE 472, EN 61000-4-12	Yes	Yes																										
Dry Test	Heat IEC 68-2-2 or equivalent	No	Yes																										
Damp test	Heat IEC 68-2-2 or equivalent	No	Yes																										
Vibration test	IEC 68-2-2 or equivalent	No	Yes																										
Electrostatic discharge test	EN 61000-4-2 or equivalent	No	Yes																										
Radio frequency immunity test	EN 61000-4-3 or equivalent	No	Yes																										
Electromagnetic field immunity	EN 61000-4-3 or equivalent	No	Yes																										
	<table><tr><td>TECHNICAL SPECIFICATION SECTION - VI PART-B</td><td>IIIC-07 TYPE TEST REQUIREMENTS</td><td>PAGE 7 OF 10</td></tr></table>	TECHNICAL SPECIFICATION SECTION - VI PART-B	IIIC-07 TYPE TEST REQUIREMENTS	PAGE 7 OF 10																									
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**Project: 400/132 kV Switchyard Package at
Nabinagar Super Thermal Power Project (3 X 660 MW)
Customer: Nabinagar Power Generating Co. Pvt.
Limited (NPGC)
Consultant: -----**

**Bharat Heavy Electricals Limited
Document No. TB 350 510 020B**

Technical Specification: 1.1 kV Aux Power & Control Cables

SECTION-2

2.0 SCOPE

This technical specification covers the requirement of design, manufacture, testing, packing and dispatch of 1.1 kV grade Auxiliary power and control cables (FRLS type). No deviation from the requirements specified in various clauses of this specification shall be allowed.

2.1 APPLICABLE STANDARDS

The auxiliary power and control cables shall conform to following latest Indian and International standards and their amendments.

IS 1554 (Part I)	PVC insulated (heavy duty) electric cables - For working voltage up to and including 1100V
IS 7098 (Part I)	XLPE insulated PVC sheathed cables - For working voltage up to and including 1100V
IS 5831	PVC insulation and sheath of electric cables.
IS 8130	Conductors for insulated electric cables and flexible cords.
IS 3975	Low Carbon Galvanized Steel Wires, Formed Wires and Tapes for Armouring of Cables - Specification
IS 10810	Method of tests for cables.
IEEE-383	Standard for type test of class IE electric cables, field splices, and connections for nuclear power generating stations.
ASTM-D2843	Standard test method for density of smoke from burning or decomposition of plastics.
ASTM-D2863	Standard test method for measuring minimum oxygen concentration to support candle - like combustion of plastics (oxygen index).
IEC: 60754 (Part-1 & 2)	Test on gases evolved during combustion of electric cables -
IEC: 60332 (Part I to 3)	Tests on electric and optical fibre cables under fire conditions
IS 3961 (Part II)	Recommended current rating for cables - PVC insulated and PVC sheathed heavy-duty cables.
IS 10418	Drums for electric cables.
SS 4241475	Swedish chimney test

Technical Specification: 1.1 kV Aux Power & Control Cables

2.2 CONSTRUCTIONAL FEATURES

- i) Cables shall be suitable for laying in racks, ducts, trenches, conduits and underground-buried installation with uncontrolled back fill and chances of flooding by water. They shall be designed to withstand all mechanical, electrical and thermal stresses under steady state and transient operating conditions.
- ii) The Aluminium/Copper wires used for manufacturing the cables shall be true circular in shape before stranding and shall be uniformly good quality, free from defects.
- iii) A distinct extruded inner sheath shall be provided in all armoured cable. The fillers and inner sheath shall be of non-hygroscopic, fire retardant material, softer than insulation & suitable for the operating temperature of the cable & compatible with the insulating material. The outer sheath shall be suitable for the operating temp. of the cable. For single core cable, inner sheath may not be provided.
- iv) Progressive sequential marking of the length of cable in meters at every one-meter shall be provided on the outer sheath of all cables.
- v) All power & control cables shall have an extruded outer sheath of PVC having following flame retardant & low smoke evolution properties.
Oxygen index - Minimum 29 (to ASTM D 2863).
Acid gas emission - Maximum 20% by weight (to IEC 754 – I).
Smoke density rating – Maximum 60% (to ASTM D 2843).
- vi) All cables shall be suitable for high ambient high humid tropical Indian climatic conditions.
- vii) The normal current rating of all PVC insulated cables shall be as per IS 3961.
- viii) All cables shall conform to type test and shall be subjected to routine and acceptance tests listed in the specification.
- ix) Allowable tolerance on the overall diameter of the cables shall be $\pm 2\text{mm}$.
- x) The minimum bending radius for the cables shall be equal to $12 \times D$, where D is the overall diameter of the cable for multicore cables and $15 \times D$ for single core cable.
- xi) Suitable chemicals shall be added to the outer sheath of all cables to protect from rodent, vermin and termite attack.
- xii) Repaired cables shall not be acceptable.
- xiii) Cores shall be identified as per IS 1554 (Part-I)/ IS 7098 Part-I for the cables upto five (5) cores and for cables with more than five (5) cores the identification of cores shall be done by printing legible Hindu Arabic numerals on all cores as per Clause 10.3 of IS 1554 (Part-1).
- xiv) Manufacturer's name, type of cable, number of cores, year of manufacture and sequential marking of length in metres at every one metre shall be permanently marked on the outer sheath throughout the entire length of cable.

Consultant: -----

Technical Specification: 1.1 kV Aux Power & Control Cables

2.3 CURRENT RATING FOR CONTROL and AUX. POWER CABLES

- 2.3.1 Normal current rating shall not be less than that covered by IS 3961. Vendor shall submit data in respect of all cables in the prescribed format.
- 2.3.2 PVC insulated cables shall be suitable for continuous conductor temperature of 70 °C and short circuit withstand temperature of 160 °C. Tables giving de-rating factors for various conditions of cable installation including the following, for all types of cables shall be furnished -
- Variation in ambient air temperature.
 - Variation in ground temperature.
 - Depth of laying.
 - Cables laid in the ground
 - Cables laid in trench
 - Cables laid in ducts
 - Soil resistivity.
 - Grouping of cables.

Overall derating factor for cable shall be 0.8 or less.

- 2.3.3 The value of short circuit withstand current ratings of all cables shall be indicated for a short circuit for 1 second duration and should also specify the maximum temperature during short circuit.
- 2.3.4 The following factors shall also be accounted for, while specifying the maximum short circuit withstand of the cables.
- 2.3.4.1 Deformation of the insulation, due to thermo-mechanical forces produced by the short circuit conditions, can reduce the effective thickness of insulation.
- 2.3.4.2 Conductor and core screens can be adversely affected with loss of screening effect. Likewise the thermal properties of the outer sheath material can be the limitation.
- 2.3.4.3 It is essential that the accessories, which are used in the cable system with mechanical and/or soldered connections, are suitable for the temperature adopted for the cables.
- 2.3.5 Formula for calculating short circuit current for different duration or curve showing short time current v/s time for different sizes of cables shall be furnished by vendor.

2.4 CABLE DRUMS

- 2.4.1 Cables shall be supplied in non-returnable wooden cable drum or steel drum of heavy construction. It shall be made of good quality wood, pressure impregnated against fungal and insect attack. Wood preservative shall be applied to the entire drum. The ends of the each length of cable shall be sealed before dispatch.
- 2.4.2 All Control and Power Cables shall be supplied in drum length of 1000 m, unless otherwise specified. For power cable with conductor cross sectional area 300sqmm and above may be

Technical Specification: 1.1 kV Aux Power & Control Cables

supplied in 500m drums. Each drum shall contain one continuous length of cable. Owner shall have the option of rejecting cable drums with shorter lengths. The cable length per drum is allowed a tolerance of $\pm 5\%$. The tolerance allowed on total quantity of each size is $\pm 2\%$. Where the ordered quantity is not multiple of 1000/500 m and the incremental quantity is very small, the same may be included in one of the drums. Otherwise, an additional length for the incremental quantity will be supplied.

- 2.4.3 A layer of water proof paper shall be applied to the surface of the drums and over the outer most cable layer.
- 2.4.4 A clear space of at least 40mm shall be left between the cables and the logging.
- 2.4.5 Each drum shall carry manufacturer's name, purchaser's name, address and contract number, item number and type, size and length of the cable, net and gross weight stenciled on both sides of drum. A tag containing the same information shall be attached to the leading end of the cable. An arrow and suitable accompanying wordings shall be marked on one end of the reel indicating the direction in which it should be rolled.
- 2.4.6 Packing shall be sturdy and adequate to protect the cables, from any injury due to mishandling or other conditions encountered during transportation, handling and storage. Both cable ends shall be sealed with PVC/Rubber caps so as to eliminate ingress of water during transportation and erection.

2.5 TESTS

All types and sizes of cables shall be subjected to following routine and acceptance tests and type tests.

2.5.1 Type and Acceptance test

The following test shall be performed on one length from each manufacturing series of same type and size of cable, covering at least 10% of all cable drums / test reports shall be submitted as per Section-5. The type and acceptance tests shall be witnessed by purchaser / purchaser's representatives.

- a) Annealing test (for Copper conductor), Tensile & Wrapping Tests (for Aluminium for conductor) as per IS 8130.
- b) Conductor resistance test as per IS 8130.
- c) Test for armouring wires/ formed wire (% Elongation, Tensile, Torsion/ winding, Resistance, Wt of Zinc coating, Dimension and uniformity of coating) as per IS 1554 (Part-I), IS 7098 (Part-I), IS 3975.
- d) Check for dimensions of insulation, sheath and conductor as per IS 1554 (Part-I), IS 7098 (Part-I).
- e) Physical tests for insulation and sheath as per IS 1554 (Part-I), IS 7098 (Part-I), IS 5831 as applicable.

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- f) Insulation resistance test as per IS 1554 (Part-I), IS 7098 (Part-I), IS 5831 as applicable.
- g) High voltage test at room temperature as per IS 1554 (Part I), IS 7098 (Part-I) as applicable.
- h) High voltage test (water immersion test) as per clause 16.3 of IS 1554 (Part I).
- i) Flammability test as per clause 2.5 IEEE-383 / IEC 60332 part 3.
- j) Smoke density rating test as per ASTM-D2843.
- k) Oxygen index and Temperature index test as per ASTM-D2863.
- l) Acid gas generation test as per IEC: 60754
- m) Flammability test as per IS 1554 Part-I/ IS 7098 Part-1.
- n) Swedish chimney test F3 category as per SS 4241475

~~Following special type tests shall be performed on one sample from each lot of the offered cables:~~

- ~~a) Hydraulic Stability Test~~
- ~~b) Ultraviolet Test as per DIN 53387~~

2.5.2 Routine tests

The following routine tests shall be conducted on full length of the cable. These shall be witnessed by purchaser / purchaser's representatives.

- a) High voltage test as per clause 16.2 of IS 1554 (Part I).
- b) Conductor resistance test as per clause 6.3 of IS 8130.

SECTION-3

PROJECT DETAILS & GENERAL TECHNICAL REQUIREMENTS

3.0 GENERAL

This section stipulates the General Technical Requirements under the Contract and will form an integral part of the Technical Specification.

The provisions under this section are intended to supplement general requirements for the materials, equipment and services covered under other sections of tender documents and are not exclusive. However in case of conflict between the requirements specified in this section and requirements specified under other sections, the requirements specified under respective sections shall prevail.

3.1 PROJECT INFORMATION:

	Particular	Details	
a)	Customer	Nabinagar Power Generating Company Pvt. Ltd. (NPGC) (A joint venture of NTPC Ltd. and Bihar State Electricity Board)	
b)	Project Title	400/132 kV Switchyard including 400 kV & 33 kV Transmission Lines for Nabinagar Super Thermal Power Project (3X660 MW) at Nabinagar, Bihar and extension of two line bays at 4X250MW Nabinagar TPP	
c)	Location	Nabinagar STPP (i.) Place : Nabinagar (ii) District : Aurangabad (iii.) State : Bihar	Nabinagar TPP (BRBCL) (i.) Place : Nabinagar (ii) District : Aurangabad (iii.) State : Bihar
d)	Nearest Road Head	National Highway-2 (Approximately 25 kms from National highway)	
e)	Nearest Rail Head	Dehri-On-Sone (Approximately 30 kms from Railway Station)	

SITE CONDITIONS

a)	Max. ambient air temp.	50°C
b)	Min. ambient air temp.	0°C
c)	Max. design ambient temp.	50°C
d)	Design reference RH	100 %
e)	Altitude	<500 MSL
f)	Pollution Severity	High Pollution level (25mm/kV)
g)	Seismic Zone	Zone-III

WIND DATA

a)	Basic Wind speed	47m/sec
b)	The risk co-efficient (K1)	1.07
c)	Category of terrain	Category-2

d)	Maximum wind pressure on steel members	1500 N/m ²
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3.1.1 SYSTEM PARAMETERS:

Sl.No.	Parameters	400 kV	132 kV	33 kV
1	Highest system voltage	420 kVrms	145 kVrms	36 kVrms
2	Lightning Impulse voltage	±1425kVp	± 650kVp	± 170kVp
3	Switching impulse voltage	±1050kVp	--	--
4	Power frequency withstand for 1 min (rms)	630 kV(rms)	275 kV(rms)	70 kV(rms)
5	Max. fault level (1 sec.)	50 kA	31.5kA	25 kA
6	Minimum creepage distance	10500 mm	3625mm	900 mm

3.1.2 AUXILIARY POWER:

Sl.No.	Nominal Connection Voltage	Variations in Voltage	Frequency	Phase	Neutral
1	415V	±10%	50±5%	3	Solidly Earthed
2	240V	±10%	50±5%	4	Solidly Earthed

Combined variation of voltage and frequency shall be + 10%. Fault level of 415V system shall not be less than 20kA.

The minimum height of equipment supports shall be 2550mm. The various minimum heights of the switchyard shall be as given below from plinth level :

Voltage	Equipment/1 st Level	2 nd Level	3 rd Level
132kV	4600mm	8500mm	12500mm
400kV (1½ Breaker)	8000mm	16000mm	--

3.2 INSTRUCTION TO BIDDERS:

The bidders shall submit the technical requirements, data and information as per the technical data sheets, provided in Section-4.

The bidders shall furnish catalogues, engineering data, technical information, design documents, drawings etc fully in conformity with the technical specification.

It is recognized that the bidders may have standardized on the use of certain components, materials, processes or procedures different than those specified herein. Alternate proposals offering similar equipment based on the manufacturer's standard practice will also be considered provided such proposals meet the specified designs, standard and performance requirements and are acceptable to the Purchaser. Unless brought out clearly,

the Bidder shall be deemed to conform to this specification scrupulously. All deviations from the specification shall be clearly brought out in the respective schedule of deviations. Any discrepancy between the specification and the catalogues or the bid, if not clearly brought out in the schedule, will not be considered as valid deviation.

Except for lighting fixtures, wherever a material or article is specified or defined by the name of a particular brand, Manufacturer or Vendor, the specific name mentioned shall be understood as establishing type, function and quality and not as limiting competition. For lighting fixtures, makes shall be as defined in Section-Lighting System.

Equipment furnished shall be complete in every respect with all mountings, fittings, fixtures and standard accessories normally provided with such equipment and/ or needed for erection, completion and safe operation of the equipment as required by applicable codes, though they may not have been specifically detailed in the Technical Specifications unless included in the list of exclusions. Materials and components not specifically stated in the specification but which are necessary for commissioning and satisfactory operation of the switchyard unless specifically excluded shall be deemed to be included in the scope of the specification and shall be supplied without any extra cost. All similar standard components/parts of similar standard equipment under supply shall be inter-changeable with one another.

The bidder shall supply type tested (including special tests as per tech. specification) equipment and materials. The test reports shall be furnished by the bidder along with equipment/ material drawings. In the event of any discrepancy in the test reports, (i.e., if any test report is not acceptable due to any design/ manufacturing changes or due to non-compliance with the Technical Specification and/ or applicable standard), the tests shall be carried out without any additional cost implication to the BHEL. BHEL reserves the right to get any or all type/tests conducted/repeated.

3.3 STANDARDS

- 3.3.1** The Contractor is required to follow local statutory regulations stipulated in the latest amended Electricity Supply Act 1948 and Indian Electricity Rules 1956, and other local rules and regulations.
- 3.3.2** The equipment to be furnished under this specification shall conform to latest issue with all amendments of standards and/or codes specified under respective section heads. The standards mentioned in the specification are not mutually exclusive or complete in themselves, but intended to compliment each other. The Contractor shall also note that list of standards presented in this specified is not complete. Whenever necessary the list of standards shall be considered in conjunction with specific IS/IEC. When the specified requirements stipulated in the specifications exceed or differ than those required by the applicable standards, the stipulation of the specification shall take precedence.
- 3.3.3** Other internationally accepted standards which ensure equivalent or better performance than that specified in the standards referred under section shall also be acceptable.
- 3.3.4** In case governing standards for the equipment is different from IS or IEC, the salient points of difference shall be clearly brought out in additional information schedule alongwith English language version of standard of relevant extract of the same. The equipment conforming to standards other than IS/IEC shall be subject to Employer's

approval.

3.3.5 The full names of the codes and standards mentioned in abbreviations under various equipment heads are as follows:

BS British Standards

IEC/CISPR International Electro-technical Commission

IS Bureau of Indian Standards

ISO International Organisation for Standards

NEMA National Electric Manufacturers Association

3.4 SERVICES TO BE PERFORMED BY THE EQUIPMENT BEING FURNISHED

The 400 kV system is being designed to limit the power frequency over voltage of 1.5 p.u. and the switching surge over voltage to 2.5 p.u. In 400 kV system the initial value of temporary over voltage could be 2.0 p.u. for 1-2 cycles. All the equipment/materials covered in this specification shall perform all its function satisfactorily without undue strain, restrike etc. under such over voltage conditions. All equipment shall also perform satisfactorily under various other electrical, electromechanical and meteorological conditions of the site of installation. All equipment shall be able to withstand all external and internal mechanical, thermal and electromechanical forces due to various factors like wind load, temperature variation, ice & snow, (not applicable for this project) short circuit etc for the equipment.

The equipment shall also comply with the following:

- a) All equipments shall be suitable for hot line washing.
- b). To facilitate erection of equipment, all items to be assembled at site shall be "match marked".
- c) Piping, if any, between equipment control cabinet or operating mechanism to marshalling box of the equipment, shall bear proper identification to facilitate the connection at site.
- d) All equipment shall be supplied with necessary interpole cabling, and its cost shall be included in the cost of equipment.

3.5 ENGINEERING DATA

3.5.1 Drawings

All drawings submitted by the supplier including those submitted at the time of bid shall be in sufficient detail to indicate the type, size, arrangement, material description, Bill of Materials, weight of each component, break-up for packing and shipment, the external connections, fixing arrangement required. The dimensions required for installation and interconnections with other equipment and materials, clearances and spaces required for installation and interconnections between various portions of equipment and any other information specifically requested in the specifications.

Each drawing submitted by the Contractor shall be clearly marked with the name of the Purchaser, the unit designation, the specifications title, the specification number and the name of the Project. If standard catalogue pages are submitted, the applicable items shall be indicated therein. All titles, noting, markings and writings on the drawing shall be in English. All the dimensions should be in metric units.

Further work by the Contractor shall be in strict accordance with these drawings and no

deviation shall be permitted without the written approval of the Purchaser, if so required.

The review of these data by the purchaser will cover only general conformance of the data to the specification and documents, interfaces with the equipment provided under specification, external connections and of the dimensions which might affect substation layout.. This review by the purchaser may not indicate a thorough review of the dimensions, quantities and details of the equipment, material, any devices or items indicated or the accuracy of the information submitted. This review and/or approval by the purchaser shall not be considered by the contractor, as limiting any of his responsibilities and liabilities for mistakes and deviations from the requirements, specified under these specifications and documents.

All manufacturing and fabrication work in connection with the equipment prior to the approval of the drawings shall be at the Contractor's risk. The Contractor may make any changes in the design which are necessary to make the equipment conform to the provisions and intent of the Contract and such changes will again be subject to approval by the Purchaser. Approval of Contractor's drawing or work by the Purchaser shall not relieve the contractor of any of his responsibilities and liabilities under the Contract.

All engineering data submitted by the contractor after final process including review and approval by the purchaser shall form part of the contract document and the entire work performed under these specifications shall be performed in strict conformity, unless otherwise expressly requested by the purchaser in writing.

3.5.2 Approval Procedure

The following procedure for submission and review/approval of the drawings, data, reports, information, etc. shall be followed by Contractor:

- a. All data/information furnished by Vendor in the form of drawings, documents, catalogues or in any other form for NTPC's information/interface and/or review and approval are referred by the general term "drawings".
- b. The 'Master drawings list' shall be submitted for review and approval of Employer before award of contract. The Contractor shall have to prepare and submit any other drawings and reference documents in addition to the drawings contained in the list, if so required during engineering stage as felt necessary by the Employer. Number of copies of the list for the distribution shall be as mutually agreed between Contractor and Employer.
- c. All drawings (including those of subvendors') shall bear at the right hand bottom corner the 'title block' with all relevant information duly filled in. The format of title block shall approved by Engineer within thirty (30) days after the letter of award. The Contractor shall give this format to his subvendor along with his purchase order for subvendor's compliance. The size of title block basic format and its contents shall not be changed. All drawings shall be in English language. All dimensions shall be in metric units.
- d. Contractor shall submit all the drawings in five (5) copies for review of Employer. Employer shall forward their comments within four (4) weeks of receipt of drawings.
- e. Upon review of each drawings, depending on the correctness and completeness of the drawings, the same will be categorised and approval accorded in one of the following categories:

CATEGORY I	Approved
CATEGORY II	Approved subject to incorporation of comments/modification as noted. Resubmit revised drawing incorporating the comments
CATEGORY III	Not approved. Resubmit revised drawings for Approval after incorporating comments/modifications as noted
CATEGORY IV	For information and records

- f. Contractor shall resubmit the drawings approved under Category II and III within three (3) weeks of receipt of comments on the drawings, incorporating all comments. Every revision of the drawing shall bear a revision index wherein such revisions shall be highlighted in the form of description or marked up in the drawing identifying the same with relevant revision number enclosed in a triangle (e.g 1.2.3. etc.)
- g. In case Contractor does not agree with any specific comment, he shall furnish the explanation for the same to Employer consideration. In all such cases Contractor shall necessarily enclose explanations along with the revised drawing (taking care of balance comments) to avoid any delay and/or duplication in review work.
- h. It is the responsibility of the Contractor to get all the drawings approved in the Category I or IV (as the case may be) and complete engineering activities within the agreed schedule. Any delay arising out of submission and modification of drawings shall not alter the contract completion schedule.
- i. Contractor shall not make any changes in the portion of the drawing other than those commented. If changes are required to be made in the portions already approved, the Contractor shall resubmit the drawings identifying the changes (alongwith reasons for changes) for Employer's review and approval.
- j. Approval of drawings will not in any way relieve the Contractor of his obligations of furnishing the equipment in accordance with the specification and shall not prevent subsequent rejection if such equipment is later found to be defective.
- k. The drawing approval progress report shall be submitted in at least three (3) copies within one (1) week from the last date of the every month.

3.5.3 Erection Drawings.

- a. Contractor shall furnish erection drawings for the guidance or commencement of erection or the first shipment, whichever is earlier. These shall generally comprise of fabrication/assembly drawings, various component/part details drawing, assembly, clearance data requirements, etc. The drawings shall contain details of components/ equipment with identification number, match marks, bill of materials, assembly procedures etc.
- b. For all major equipment apart from above details, assembly sequence and instructions with check-lists shall be furnished in the form of erection manuals.

3.5.4 Instruction Manual

- a. The Contractor shall submit to the Employer preliminary instruction manuals for all the equipments for review. The final instructions manuals incorporating Employer's comments and complete in all respect shall be submitted at least thirty (60) days before the first shipment of the equipment. The instruction manuals shall contain full details and drawings of all the equipments, the transportation, storage, installation, testing, operation and maintenance procedures, etc. separately for each component/equipment alongwith log record format. These instruction manuals shall be submitted in five (5) copies for approval.
- b. If after commissioning and initial operation of the plant, the instruction manuals require any modifications/additions/changes, the same shall being corporated and the updated final instruction manuals shall be submitted .
- c. The operating and maintenance instructions together with drawings (other than shop drawings) of the equipment, as completed, shall have sufficient details to enable the Employer to maintain, dismantle, reassemble and adjust all parts of the equipment. They shall give a step by step procedure for all operations likely to be carried out during the life of the plant/equipment, including erection, testing, commissioning, operation, maintenance dismantling and repair. Each manual shall also include a complete set of approved drawings together with performance/rating curves of the equipment and test certificates, wherever applicable. The contract shall not be considered completed for purpose of taking over until such instructions and drawings have been supplied to the Employer.
- d. A separate section of the manual shall be for each size/type of equipment and shall contain a detailed description of construction and operation, together will all relevant pamphlets, drawings and list of parts with procedures for ordering spares. Maintenance instructions shall include charts showing lubrication, checking, testing and replacement procedure to be carried out daily, weekly, monthly and at longer intervals to ensure trouble free operation. Where applicable, fault location charts shall be included to facilitate finding the cause of mal-operation or breakdown. A collection of the manufacturer's standard leaflets will not accepted to be taken as a compliance of this clause. The manual shall be specifically compiled for the concerned project.

3.5.5 Final Submission of drawings and documents:

The Contractor shall furnish the following after approval of all drawings /documents and test reports:

- a. List of drawings bearing the Employer's and Contractor's drawing number.
- b. Ten (10) bound sets alongwith 4 CD-ROMs of all drawing.
- c. All documents/designs in five (5) copies as noted above.
- d. Contractor shall also furnish nine (9) bound sets of all as-built drawings including the list of all as-built drawings bearing drawing numbers. The Contractor shall also furnish four (4) sets of film reproducibles or CD-ROMs of all as-built drawings as decided by the Employer.
- e. The Contractor shall also furnish eleven (11) copies of instruction manuals (after approval) for all the equipments.

3.5.6 TEST REPORTS

Five (5) copies of all test reports shall be supplied for approval before shipment of equipment. The report shall indicate clearly the standard value specified for each test to facilitate checking of the reports. After final approval seven bound copies of all type and routine test reports shall be submitted to Employer.

3.6 MATERIAL /WORKMANSHIP

Where the specification does not contain references to workmanship, equipment, materials and components of the covered equipment, it is essential that the same must be new, of highest grade of the best quality of their kind, conforming to best engineering practice and suitable for the purpose for which they are intended and shall ensure satisfactory performance throughout the service life.

In case where the equipment, materials or components are indicated in the specification as "similar" to any special standard the purchaser shall decide upon the question of similarity. When required by the specification or when required by the purchaser the contractor shall submit, for approval, all the information concerning the materials or components to be used in manufacture. Machinery, equipment, materials and components supplied, installed or used without such approval shall run the risk of subsequent rejection, it being understood that the cost as well as the time delay associated with the rejection shall be borne by the Contractor.

The design of the Works shall be such that installation, future expansions, replacements and general maintenance may be undertaken with a minimum of time and expenses. Each component shall be designed to be consistent with its duty and suitable factors of safety subject to mutual agreements. All joints and fastenings shall be devised, constructed and documented so that the component parts shall be accurately positioned and restrained to fulfill their required function. In general, screw threads shall be standard metric threads. The use of other thread forms will only be permitted when prior approval has been obtained from the Purchaser.

Whenever possible, all similar part of the works shall be made to gauge and shall also be made interchangeable with similar parts. All spare parts shall also be interchangeable and shall be made of the same materials and workmanship as the corresponding parts of the equipment supplied under the specification. Where feasible, common component units shall be employed in different pieces of equipment in order to minimize spare parts stocking requirements. All equipment of the same type and rating shall be physically and electrically interchangeable.

The equipment offered in the bid only shall be accepted for supply, with the minimum modifications as agreed/accepted.

3.7 LIMIT OF CONTRACT

All the equipment, materials and services furnished by the manufacturer shall be complete in every respect with all mountings, fitting, fixtures and standard accessories normally provided with such equipment, and needed for erection, completion and safe operation of the equipment as required by applicable codes though they may not have been specifically detailed in technical specification and unless included in the list of exclusions. The

manufacturer shall supply at no extra cost to Employer any additional material/service not covered specifically but which are found to be required for fulfillment of the scope of work under specification.

3.8 PROVISIONS FOR EXPOSURE TO HOT AND HUMID CLIMATE

Outdoor equipment supplied under the specification shall be suitable for service and storage under tropical conditions of high temperature, high humidity' heavy rainfall and environment favorable to the growth of fungi and mildew. The indoor equipment located in non-air-conditioned areas shall also be of same type.

SPACE HEATERS

The heaters shall be suitable for continuous operation at 230 V as supply voltage. On - off switch and fuse shall be provided.

One or more adequately rated thermostatically connected heaters shall be supplied to prevent condensation in any compartment. The heaters shall be installed in the compartment and electrical connections shall be made sufficiently away from below the heaters to minimize deterioration of supply wire insulation. The heaters shall be suitable to maintain the compartment temperature to prevent condensation.

The heaters shall be suitably designed to prevent any contact between the heater wire and the air and shall consist of coiled resistance wire centered in a metal sheath and completely encased in a highly compacted powder of magnesium oxide or other material having equal heat conducting and electrical insulation properties or they shall consist of resistance wire wound on a ceramic and completely covered with a ceramic material to prevent any contact between the wire and the air. Alternatively, they shall consist of a resistance wire mounted into a tubular ceramic body built into an envelope of stainless steel or the resistance wire is wound on a tubular ceramic body and embedded in vitreous glaze. The surface temperature of the heaters shall be restricted to a value which will not shorten the life of the heater sheaths or that of insulated wire or other component in the compartments.

FUNGI STATIC VARNISH

Besides the space heaters, special moisture and fungus resistance varnish shall be applied on parts which may be subjected or predisposed to the formation of fungi due to the presence or deposit of nutrient substances. The varnish shall not be applied to any surface of part where the treatment will interfere with the operation or performance of the equipment. Such surfaces or parts shall be protected against the application of the varnish.

Ventilation opening

In order to ensure adequate ventilation, compartments shall have ventilation openings provided with fine wire mesh of brass to prevent the entry of insects and to reduce to a minimum the entry of dirt and dust. Outdoor compartment openings shall be provided with shutter type blinds.

Degree of Protection

The enclosure of the Control Cabinets, Junction boxes and Marshalling Boxes, panels etc. to be installed shall provide degree of protection as detailed here under:

- a) Installed out door: IP- 55
- b) Installed indoor in air conditioned area: IP-31
- c) Installed in covered area: IP-52
- d) Installed indoor in non air-conditioned area where possibility of entry of water is limited: IP-41.
- e) For LT Switchgear (AC & DC distribution Boards) : IP-52

The degree of protection shall be in accordance with IS: 13947 (Part –I) / IEC-947 (Part-I) / IS 12063/IEC 529. Type test report for degree of protection test, on each type of the box shall be submitted for approval.

3.9 RATING PLATES, NAME PLATES AND LABELS

- 3.9.1** The equipment nameplate should preferably be of stainless steel. In case of aluminium, it should be at least 2mm thick.. The inscription on the nameplate shall be engraved and no punching shall be accepted except for equipment serial number and year of manufacture. These nameplates shall be black with white engraved lettering.
- 3.9.2** The rated current, extended current rating and rated thermal current shall be clearly indicated in the name plate in case of current transformer.
- 3.9.3** Rated voltage, voltage factor and intermediate voltage shall be clearly indicated on the nameplate in case of capacitor voltage transformer.
- 3.9.4** Name plates of cubicles and panels may be made of non-rusting metal or 3 ply lamicaid.
- 3.9.5** Each switch shall a clear inscription identifying its function. Switches shall also have a clear inscription of each position indication.

3.10 GALVANISING :

- 3.10.1** The galvanised surface shall consist of a continuous film adhering to the steel. The finished surface shall be clean and smooth, and shall be free from defects like dissolved patches, base, spot, unevenness of coating, spelter which is loosely attached to the steel globules, spiky deposits, blistered surfaces, flaking or peeling off, etc. The presence of any of these defects shall render the material liable to rejection.
- 3.10.2** All exposed ferrous parts shall be hot dip galvanised as per IS:2629 & IS:2633, Galvanising shall be uniform, smooth continuous and free from acidspots. Should the galvanising of the sample be found defective, the entire batch of steel shall have to be re-galvanised at Contractor's cost. The amount of zinc deposit shall be not less than 610 gms. per sq.m. of surface area and in addition, the thickness of zinc at any spot shall not be less than 85 microns. The Employer reserves the right to measure the thickness of zinc deposit by Elkometer or any other instrument acceptable to Employer and reject any component which shows thickness of zinc at any location less than 85 microns. The testing on the galvanised materials shall be carried out as per IS:2633.

- 3.10.3** The amount of zinc deposit over threaded portion of the bolts, nuts and screws shall not be less than 300 gms. per sq. meter of surface area. The amount of zinc deposit on washers shall not be less than 340 gms. per sq. meter of surface area. The threads having extra deposit of zinc shall be removed by die cutting after the completion of galvanising. The removal of extra zinc shall be carefully done so that threads shall have minimum deposits of zinc on them as specified.

3.11 PAINTING

The sheet steel to be painted shall be pretreated in tanks in accordance with IS:6005. Degreasing shall be done by alkaline cleaning. Rust and scales shall be removed by pickling with acid. After pickling, the parts shall be washed in running water. Then these shall be rinsed in slightly alkaline hot water and dried. The phosphate coating shall be "class-C" as specified in IS:6005. The phosphated surfaces shall be rinsed and passivated prior to application of stoved lead oxide primer coating. After primer application, two coats of finishing synthetic enamel paint on panels shall be applied. Electrostatic painting shall also be acceptable. Finishing paint on outside of the panels shall be as required otherwise by the Employer. The inside of the panels shall be glossy white. Each coat of finishing shall be properly stoved. The paint thickness shall not be less than 50 microns. Finished parts shall be coated by peelable compound by spraying method to protect the finished surfaces from scratches, grease, dirt and oil spots during testing, transportation, handling and erection.

3.12 QUALITY ASSURANCE PROGRAMME

- 3.12.1** The Contractor shall adopt suitable quality assurance programme to ensure that the equipment and services under the scope of contract whether manufactured or performed within the Contractor's works or at his subcontractor's premises or at the Employer's site or at any other place of work are in accordance with the specifications. Such programmes shall be outlined by the Contractor and shall be finally accepted by the Employer/authorised representative after discussions before the award of the contract. The QA programme shall be generally in line with ISO-9001/IS- 14001.

A quality assurance programme of the contractor shall generally cover the following:

- i. His organisation structure for the management and implementation of the proposed quality assurance programme
- ii. Quality System Manual
- iii. Design Control System
- iv. Documentation Data Control System
- v. Qualification data for Bidder's key Personnel.
- vi. The procedure for purchase of materials, parts, components and selection of sub-contractor's services including vendor analysis, source inspection, incoming raw-material inspection, verification of materials purchased etc.
- vii. System for shop manufacturing and site erection controls including process, fabrication and assembly.
- viii. Control of non-conforming items and system for corrective actions and resolution of deviations.
- ix. Inspection and test procedure both for manufacture and field activities.

- x. Control of calibration and testing of measuring testing equipments.
- xi. System for Quality Audits.
- xii. System for identification and appraisal of inspection status.
- xiii. System for authorising release of manufactured product to the Employer.
- xiv. System for handling storage and delivery.
- xv. System for maintenance of records, and
- xvi. Furnishing quality plans for manufacturing and field activities detailing out the specific quality control procedure adopted for controlling the quality characteristics relevant to each item of equipment/component.

3.12.2 GENERAL REQUIREMENTS - QUALITY ASSURANCE

- 3.12.2.1 All materials, components and equipment covered under this specification shall be procured, manufactured, erected, commissioned and tested at all the stages, as per a comprehensive Quality Assurance Programme. An indicative programme of inspection/tests to be carried out by the contractor for some of the major items is given in the respective technical specification.
This is, however, not intended to form a comprehensive programme as it is the contractor's responsibility to draw up and implement such programme duly approved by the Employer. The detailed Quality Plans for manufacturing and field activities should be drawn up by the Bidder and will be submitted to Employer for approval. Schedule of finalisation of such quality plans will be finalised before award.
- 3.12.2.2 Manufacturing Quality Plan will detail out for all the components and equipment, various tests/inspection, to be carried out as per the requirements of this specification and standards mentioned therein and quality practices and procedures followed by Contractor's/ Sub-contractor's/ sub-supplier's Quality Control Organisation, the relevant reference documents and standards, acceptance norms, inspection documents raised etc., during all stages of materials procurement, manufacture, assembly and final testing/performance testing. The Quality Plan shall be submitted on electronic media e.g. floppy or E-mail in addition to hard copy, for review. Once the same is finalised, hard copies shall be submitted for approval. After approval the same shall be submitted in compiled form on CD ROM.
- 3.12.2.3 Field Quality Plans will detail out for all the equipment, the quality practices and procedures etc. to be followed by the Contractor's site Quality Control Organisation, during various stages of site activities starting from receipt of materials/equipment at site.
- 3.12.2.4 The Bidder shall also furnish copies of the reference documents/plant standards/acceptance norms/tests and inspection procedure etc., as referred in Quality Plans alongwith Quality Plans. These Quality Plans and reference documents/standards etc. will be subject to Employer's approval without which manufacturer shall not proceed.
These approved documents shall form a part of the contract. In these approved Quality Plans, Employer shall identify customer hold points (CHP), i.e. test/checks which shall be carried out in presence of the Employer's Project Manager or his authorised representative and beyond which the work will not proceed without consent of Employer/Authorised representative in

writing. All deviations to this specification, approved quality plans and applicable standards must be documented and referred to Employer alongwith technical justification for approval and dispositioning.

- 3.12.2.5 No material shall be despatched from the manufacturer's works before the same is accepted subsequent to predespatch final inspection including verification of records of all previous tests/inspections by Employer's Project Manager/Authorised representative and duly authorised for despatch by issuance of MDCC.
- 3.12.2.6 All material used for equipment manufacture including casting and forging etc. shall be of tested quality as per relevant codes/standards. Details of results of the tests conducted to determine the mechanical properties, chemical analysis and details of heat treatment procedure recommended and actually followed shall be recorded on certificates and time temperature chart. Tests shall be carried out as per applicable material standards and/or agreed details.
- 3.12.2.7 All welding and brazing shall be carried out as per procedure drawn and qualified in accordance with requirements of ASME Section IX/BS-4870 or other International equivalent standard acceptable to the Employer. All welding/brazing procedures shall be submitted to the Employer or its authorised representative for approval prior to carrying out the welding/brazing.
- 3.12.2.8 All brazers, welders and welding operators employed on any part of the contract either in Contractor's/his sub-contractor's works or at site or elsewhere shall be qualified as per ASME Section-IX or BS-4871 or other equivalent International Standards acceptable to the Employer.
- 3.12.2.9 Test results or qualification tests and specimen testing shall be furnished to the Employer for approval. However, where required by the Employer, tests shall be conducted in presence of Employer/authorised representative.
- 3.12.2.10 For all pressure parts and high pressure piping welding, the latest applicable requirements of the IBR (Indian Boiler Regulations) shall also be essentially complied with. Similarly, any other statutory requirements for the equipments/systems shall also be complied with.
- 3.12.2.11 All the heat treatment results shall be recorded on time temperature charts and verified with recommended regimes.
- 3.12.2.12 No welding shall be carried out on cast iron components for repair.
- 3.12.2.13 Unless otherwise proven and specifically agreed with the Employer, welding of dissimilar materials and high alloy materials shall be carried out at shop only.
- 3.12.2.14 All non-destructive examination shall be performed in accordance with written procedures as per International Standards, The NDT operator shall be qualified as per SNT-TC-IA (of the American Society of non-destructive examination). NDT shall be recorded in a report which includes details of methods and equipment

used, result/evaluation, job data and identification of personnel employed and details of co-relation of the test report with the job.

- 3.12.2.15 For components/equipment procured by the contractors for the purpose of the contract, after obtaining the written approval of the Employer, the contractor's purchase specifications and inquiries shall call for quality plans to be submitted by the suppliers. The quality plans called for from the subcontractor shall set out, during the various stages of manufacture and installation, the quality practices and procedures followed by the vendor's quality control organisation, the relevant reference documents/standards used, acceptance level, inspection of documentation raised, etc..

Such quality plans of the successful vendors shall be finalised with the Employer and such approved Quality Plans shall form a part of the purchase order/contract between the Contractor and sub-contractor. Within three weeks of the release of the purchase orders/contracts for such bought out items/components, a copy of the same without price details but together with the detailed purchase specifications, quality plans and delivery conditions shall be furnished to the Employer on the monthly basis by the Contractor.

- 3.12.2.16 Employer reserves the right to carry out quality audit and quality surveillance of the systems and procedures of the Contractor's or their subvendor's quality management and control activities. The contractor shall provide all necessary assistance to enable the Employer carry out such audit and surveillance.

- 3.12.2.17 The contractor shall carry out an inspection and testing programme during manufacture in his work and that of his sub-contractor's and at site to ensure the mechanical accuracy of components, compliance with drawings, conformance to functional and performance requirements, identity and acceptability of all materials parts and equipment. Contractor shall carry out all tests/inspection required to establish that the items/equipments conform to requirements of the specification and the relevant codes/standards specified in the specification, in addition to carrying out tests as per the approved quality plan.

- 3.12.2.18 Quality audit/surveillance/approval of the results of the tests and inspection will not, however, prejudice the right of the Employer to reject the equipment if it does not comply with the specification when erected or does not give complete satisfaction in service and the above shall in no way limit the liabilities and responsibilities of the Contractor in ensuring complete conformance of the materials/equipment supplied to relevant specification, standard, data sheets, drawings, etc.

- 3.12.2.19 For all spares and replacement items, the quality requirements as agreed for the main equipment supply shall be applicable.

- 3.12.2.20 Repair/rectification procedures to be adopted to make the job acceptable shall be subject to the approval of the Employer/ authorised representative.

3.12.2.21 Burn in and Elevated Temperature Test Requirement for Electronics Solid State Equipment

- a. All solid state electronic systems/equipment shall be tested as a complete system/equipment with all devices connected for a minimum of 168 hours (7 Days) continuously under energized conditions prior to shipment from Manufacturing works, as per the following cycle.
- b. **Elevated Temperature Test Cycle**
During the elevated temperature test which shall be for 48 hours of the total 168 hours of testing, the ambient temperature shall be maintained at 50 deg.C. The equipment shall be interconnected with devices which will cause it to repeatedly perform all operations it is expected to perform in actual service with load on various components being equal to those which will be experienced in actual service.
During the elevated temperature test the cubicle doors shall be closed (or shall be in the position same as they are supposed to be in the field) and inside temperature in the zone of highest heat dissipating components/modules shall be monitored. The temperature rise inside the cubicle should not exceed 10 deg.C above the ambient temp. at 50 deg.C.
- c. **Burn in Test Cycle**
The 48 hours elevated temperature test shall be followed by 120 hours of burn in test as above except that the temperature shall be reduced to the ambient temperature prevalent at that time.
During the above tests, the process I/O and other load on the system shall be simulated by simulated inputs and in the case of control systems, the process which is to be controlled shall also be simulated. Testing of individual components or modules shall not be acceptable.
In case the Contractor/ sub-contractor is having any alternate established procedure of eliminating infant mortile components, the detail procedures followed by the Contractor/ sub- contractor alongwith the statistical figures to validate the alternate procedure to be forwarded.
The Contractor/Sub-contractor shall carry out routine test on 100% item at contractor/sub-contractor's works. The quantum of check/test for routine & acceptance test by employer shall be generally as per criteria/sampling plan defined in referred standards. Wherever standards have not been mentioned quantum of check/test for routine / acceptance test shall be as agreed during detailed engineering stage.

3.12.3 QUALITY ASSURANCE DOCUMENTS

- 3.12.3.1 The Contractor shall be required to submit two hard copies and two sets on CDROM of the following Quality Assurance Documents as identified in respective quality plan with tick (_) mark within three weeks after despatch of the equipment.
Typical contents of Quality Assurance Document is as below:-
 - i) Quality Plan,
 - ii) Material mill test reports on components as specified by the specification and approved Quality Plans.
 - iii) Factory test reports/results for testing required as per applicable codes and standard referred in the specification and approved Quality Plans.
 - iv) Type test report(whenever applicable).

- v) Non-destructive examination results /reports including radiography interpretation reports.
Sketches/drawings used for indicating the method of traceability of the radiographs to the location on the equipment.
- vi) Heat Treatment Certificate/Record (Time- temperature Chart)
- vii) All the accepted Non-conformance Reports (Major/Minor) / deviation, including complete technical details / repair procedure) Verification sketches, if used and methods used to verify that the inspection and testing points in the Quality Plan were performed satisfactorily
- viii) CHP / Inspection reports duly signed by the Inspector of the Employer and Contractor for the agreed Customer Hold Points.
- ix) Certificate of Conformance (COC) wherever applicable.
- x) MDCC

3.12.3.2 Similarly, the contractor shall be required to submit two hard copies and two sets on CD ROM of Quality Assurance Documents (in line with above) pertaining to field activities as per Approved Field Quality Plans and other agreed manuals/ procedures, prior to commissioning of individual system.

3.12.3.3 Due to the large variety of equipment items, it is always possible to adapt the content of the quality document to better match the particularities of any equipment. This shall be done in agreement with the Supplier and the Inspector.
The Quality Document file shall be progressively completed by the Supplier's sub-supplier to allow regular reviews by all parties during the manufacturing. Each quality document shall have a project specific Cover Sheet bearing name & identification number of equipment and including an index of its contents with page control on each document.

3.12.3.4 Before shipping any equipment, the Supplier shall make sure that the corresponding quality document or in the case of protracted phased deliveries, the applicable section of the quality document file is completed. The supplier will then notify the Inspector regarding the readiness of the quality document (or applicable section) for review.

- i) If the result of the review carried out by the Inspector of the Quality document (or applicable section) is satisfactory. The Inspector shall stamp, the quality document (or applicable section) for release.
- ii) If the quality document is unsatisfactory, the Supplier shall endeavor to correct the incompleteness, thus allowing to finalize the quality document (or applicable section) by time compatible with the requirements as per contract documents. When it is done, the quality document (or applicable section) is stamped by the Inspector.
- iii) If a decision is made to ship equipment, whereas all outstanding actions cannot be readily cleared for the release of the quality document by the time as per contract documents (or finalization of the applicable section of the quality document within one month as per corresponding shipment date). The supplier shall immediately, upon shipment of the equipment, send a copy of the quality document Review Status (signed by the Supplier Representative) to the Inspector and notify of the committed date for the completion of all outstanding actions & submission. The Inspector shall stamp the quality document for applicable section when it is effectively completed. The final quality document will be compiled and issued at the final assembly place of equipment before shipment.

3.12.4 TRANSMISSION OF QUALITY DOCUMENTS

As a general rule, two hard copies of the quality document and Two CD ROMs shall be issued to the Employer not later than 1 month after the delivery date for the corresponding equipment . One set of quality document shall be forwarded to Corporate Quality Assurance Department and other set to respective Site .

For the particular case of phased deliveries, the complete quality document to the Employer shall be issued not later than 1 month after the date of the last delivery similarly as stated above

3.13 TYPE TESTING , INSPECTION, TESTING & INSPECTION CERTIFICATE

3.13.1 The word ‘Inspector’ shall mean the Project Manager and/or his authorised representative and/or an outside inspection agency acting on behalf of the Employer to inspect and examine the materials and workmanship of the works during its manufacture or erection.

3.13.2 The Project Manager or his duly authorised representative and/or an outside inspection agency acting on behalf of the Employer shall have access at all reasonable times to inspect and examine the materials and workmanship of the works during its manufacture or erection and if part of the works is being manufactured or assembled on other premises or works, the Contractor shall obtain for the Project Manager and for his duly authorised representative permission to inspect as if the works were manufactured or assembled on the Contractor’s own premises or works.

3.13.3 The Contractor shall give the Project Manager/Inspector fifteen (15) days written notice of any material being ready for testing. Such tests shall be to the Contractor’s account except for the expenses of the Inspector’s. The Project Manager/Inspector, unless the witnessing of the tests is virtually waived, will attend such tests within fifteen (15) days of the date on which the equipment is noticed as being ready for test/inspection failing which the contractor may proceed with test which shall be deemed to have been made in the inspector’s presence and he shall forthwith forward to the inspector duly certified copies of test reports in two (2) copies.

3.13.4 The Project Manager or Inspector shall within fifteen (15) days from the date of inspection as defined herein give notice in writing to the Contractor, or any objection to any drawings and all or any equipment and workmanship which is in his opinion not in accordance with the contract. The Contractor shall give due consideration to such objections and shall either make modifications that may be necessary to meet the said objections or shall inform in writing to the Project Manager/Inspector giving reasons therein, that no modifications are necessary to comply with the contract.

3.13.5 When the factory tests have been completed at the Contractor’s or subcontractor’s works, the Project Manager /Inspector shall issue a certificate to this effect fifteen (15) days after completion of tests but if the tests are not witnessed by the Project Manager /Inspectors, the certificate shall be issued within fifteen (15) days of the receipt of the Contractor’s test certificate by the Project Manager /Inspector. Project Manager /Inspector to issue such a certificate shall not prevent the Contractor from proceeding with the works. The completion of these tests, or the issue of the certificates shall not bind the Employer to accept the equipment should it, on further tests after erection be found not to comply with the contract.

3.13.6 In all cases where the contract provides for tests whether at the premises or works of the Contractor or any sub-contractor, the Contractor, except where otherwise specified shall

provide free of charge such items as labour, material, electricity, fuel, water, stores, apparatus and instruments as may be reasonably demanded by the Project Manager /Inspector or his authorised representatives to carry out effectively such tests on the equipment in accordance with the Contractor and shall give facilities to the Project Manager/Inspector or to his authorised representative to accomplish testing.

3.13.7 The inspection by Project Manager / Inspector and issue of Inspection Certificate thereon shall in no way limit the liabilities and responsibilities of the Contractor in respect of the agreed Quality Assurance Programme forming a part of the contract.

3.13.8 To facilitate advance planning of inspection in addition to giving inspection notice as per Clause 3.03.00, the Contractor shall furnish quarterly inspection programme indicating schedule dates of inspection at Customer Hold Point and final inspection stages. Updated quarterly inspection plans will be made for each three consecutive months and shall be furnished before beginning of each calendar month.

3.13.9 All inspection, measuring and test equipments used by contractor shall be calibrated periodically depending on its use and criticality of the test/measurement to be done. The Contractor shall maintain all the relevant records of periodic calibration and instrument identification, and shall produce the same for inspection by NTPC. Wherever asked specifically, the contractor shall re-calibrate the measuring/test equipments in the presence of Project Manager / Inspector.

3.14 PACKAGING & PROTECTION

3.14.1 Packing, Marking and shipping

The packing and shipping shall be carried out in accordance with the standard practice of Contractor and with the following additional requirements:

- a. The equipment shall be prepared in such a manner as to protect the equipment from damage or deterioration during shipping or storage. The shipments can be exposed to heavy rains, hot sun, high humidity and sudden extreme changes of temperature. The equipment shall be packed and shipped so as to protect it from all such conditions and any other abnormal conditions, generally expected during shipping & storage.
- b. The metallic containers, if any, shall be considered as the property of the Contractor and he will be allowed to remove them from site once the contents are unpacked, inspected, documented and placed in temporary storage or in final position.
- c. The equipment shall be shipped in such a manner as to facilitate unloading, handling and storage enroute and at the site. The Contractor shall provide lifting lugs and special lifting devices for proper handling and erection.
- d. The Contractor shall be liable for any damage or loss resulting due to careless, improper, poor or insufficient packing and handling.
- e. Spare parts and spare equipment shall be packed separately in containers adequate for long term storage, plainly marked "Spare Parts Only". They shall be crated individually or in kits to be used in one single renewal or overhaul operation. Other spare part kits shall not be disturbed when using one set or kit.
- f. The Contractor shall at all times protect and preserve from damage, loss, corrosion and all other forms of damage, all parts of the works.

3.14.2 Transportation

- a. The Contractor shall make a careful examination of access rail/roadways to the site in order to confirm the practical maximum transport weight and dimensions as well as a careful examination of the ports of disembarkation particularly with respect to the capacity of the cranes installed and access roads.
- b. All instruments and computer/microprocessor based equipment imported into India from overseas for the purpose of this contract shall be air freighted to the nearest possible point and further by rail/road taking due precautions as per manufacturer's recommendations. Employer shall have the right to decide the items that should be air freighted and Employer's decision shall be binding on Contractor

3.14.3 Insurance

- a. The Contractor shall insure all shipments and works at his own expense for not less than the full replacement cost plus any additional cost for accelerated manufacturing of the replacement parts.
- b. Loss or the damage to equipment during shipping or transportation to the site(s) or otherwise shall not constitute grounds for claims for extension in time or for extra payment.

3.14.4 Storage of Equipment

- a. The Contractor shall provide and construct adequate storage sheds for proper storage of equipment. Sensitive equipments shall be stored indoors. All equipment during storage shall be protected against damage due to act of nature or accidents. The storage instructions of the equipment manufacturers shall be strictly adhered to.
- b. The necessary transport packing shall be removed as soon as possible after receipt of equipment at the work site(s).

3.15 CLAMPS AND CONNECTORS INCLUDING TERMINAL CONNECTORS

- 3.15.1** The material of clamps and connectors shall be Aluminium alloy casting conforming to designation A6 of IS:617 for connecting to equipment terminals and conductors of aluminium. In case the terminals are of copper, the same clamps/connectors shall be used with 2mm thick bimetallic liner.
- 3.15.2** The material of clamps and connectors shall be Galvanised mild steel for connecting to shield wire.
- 3.15.3** Bolts, nuts and plain washers shall be hot dip galvanised mild steel for sizes M12 and above. For sizes below M12, they shall be electro-galvanised mild steel. The spring washers shall be electro-galvanised mild steel.
- 3.15.4** All castings shall be free from blow holes, surface blisters, cracks and cavities. All sharp edges and corners shall be rounded off to meet specified corona and radio interference requirements.

- 3.15.5** They shall have same current rating as that of the connected equipment. All current carrying parts shall be at least 10 mm thick. The connectors shall be manufactured to have minimum contact resistance.
- 3.15.6** Flexible connectors, braids or laminated strips shall be made up of copper/aluminium.
- 3.15.7** Current rating and size of terminal/conductor for which connector is suitable shall be put on a suitable sticker on each component which should last atleast till erection time.

3.16 CONTROL CABINETS , JUNCTION BOXES, TERMINAL BOXES & MARSHALLING BOXES FOR OUTDOOR EQUIPMENT .

- 3.16.1** All types of control cabinets, junction boxes, marshaling boxes, lighting panels, terminal boxes, operating mechanism boxes, Kiosks etc. shall generally conform to IS:5039, IS:8623 and IEC:439 as applicable.
- 3.16.2** They shall be of painted sheet steel or aluminium. The thickness of sheet steel shall be 2mm cold rolled or 2.5mm hot rolled. The thickness of aluminium shall be 3mm and shall provide rigidity. Top of the boxes shall be sloped towards rear of the box. The paint shall be of grey RAL 9002 on the outside and glossy white inside. However, the junction and switch boxes shall be of hot dip galvanised sheet steel of 1.6mm thickness.
- 3.16.3** The cabinets/boxes/kiosks/panels shall be free standing or wall mounting or pedestal mounting type. They shall have hinged doors with padlocking arrangement. All doors, removable covers and plates shall be gasketed all around with neoprene gaskets.
- 3.16.4** The degree of protection of of all the outdoor boxes shall not be less than IP 55 as per IS 2147.
- 3.16.5** The cable entry shall be from bottom, for which removable gasketed cable gland plates shall be provided.
- 3.16.6** Suitable 240V, single phase, 50Hz ac heaters with thermostats controlled by switch and fuse shall be provided to maintain inside temperature 10deg. above the ambient.
- 3.16.7** The size of enclosure and the layout of equipment inside shall provide generous clearances. Each cabinet/box/kiosk/panel shall be provided with a 15A, 240V ac, 2 pole, 3 pin industrial grade receptacle with switch. For incoming supply, MCB of suitable rating shall be provided. Illumination of each compartment shall be with door operated incandescent lamp. All control switches shall be of rotary switch type.
- 3.16.8** Each cabinet/box/kiosk/panel shall be provided with two earthing pads to receive 75mmx12mm GS flat. The connection shall be bolted type with two bolts per pad. The hinged door shall be connected to body using flexible wire. The cabinets/boxes/kiosks/panels shall also be provided with danger plate, and internal wiring diagram pasted on inside of the door. The front label shall be on a 3mm thick plastic plate with white letters engraved on black background

3.17 TERMINAL BLOCKS

- 3.17.1** They shall be non-disconnecting stud type of extensible design equivalent to Elmex type CAT-M4.
- 3.17.2** The terminal blocks shall be of 1100 V grade, and rated to continuously carry maximum expected current. The conducting part shall be tinned or silver plated.
- 3.17.3** They shall be of moulded, non-inflammable thermosetting plastic. The material shall not deteriorate with varied conditions of temperature and humidity. The terminal blocks shall be fully enclosed with removable covers of transparent, non deteriorating plastic material. Insulating barriers shall be provided between the terminal blocks so that the barriers do not hinder the wiring operation without removing the barriers.
- 3.17.4** The terminals shall be provided with marking tags for wiring identification.
- 3.17.5** Unless otherwise required (expected current rating) or specified, terminal blocks shall be suitable for connecting the following conductors on each side:
All CT & VT circuits - Min. four 2.5 sq.mm. copper flexible conductor
AC & DC power supply -Two 16 sq.mm. aluminium conductor
Circuits
Other control circuits - Min. two 2.5 sq.mm. copper flexible conductor
- 3.18.02** The terminal blocks for CT and VT secondary leads shall be provided with test links and isolating facilities. CT secondary leads shall also be provided with short circuiting and earthing facilities.

3.18 Wiring

- 3.18.1** All wiring shall be carried out with 1100 V grade stranded copper wires. The minimum size of the stranded conductor used for internal wiring shall be as follows:
a) All circuits except CT circuits 2.5 sq.mm
b) CT circuits 4 sq. mm (minimum number of strands shall be 3 per conductor).
- 3.18.2** All internal wiring shall be securely supported, neatly arranged readily accessible and connected to equipment terminals and terminal blocks.
- 3.18.3** Wire terminations shall be made with solderless crimping type of tinned copper lugs which firmly grip the conductor and insulation. Insulated sleeves shall be provided at all the wire terminations. Engraved core identification plastic ferrules marked to correspond with the wiring diagram shall be fitted at both ends of each wire. Ferrules shall fit tightly on the wires shall not fall off when the wires and shall not fall off when the wire is disconnected from terminal blocks.
- 3.18.4** All wires directly connected to trip circuit breaker shall be distinguished by the addition of a red coloured unlettered ferrule. Number 6 & 9 shall not be included for ferrules purposes.

- 3.18.5** All terminals including spare terminals of auxiliary equipment shall be wired upto terminal blocks. Each equipment shall have its own central control cabinet in which all contacts including spare contacts from all poles shall be wired out. Interpole cabling for all equipment's shall be carried out by the Contractor.

3.19 CABLE GLANDS AND LUGS

- 3.19.1** Cable glands shall be Double compression type, tinned/Nicked plated (coating thickness not less than 20 microns in case of tin and 10 to 15 microns in case of nickel) brass cable glands for all power and control cables. They shall provide dust and weather proof terminations. They shall comprise of heavy duty brass casting, machine finished and tinned to avoid corrosion and oxidation. Rubber components used in cable glands shall be neoprene and off tested quality. Required number of packing glands to close unused openings in gland plates shall also be provided.
- 3.19.2** The cable glands shall be tested as per BS:6121. The cable glands shall also be duly tested for dust proof and weather proof termination.
- 3.19.3** Cables lugs shall be tinned copper solder less crimping type conforming to IS:8309 and 8394 suitable for aluminum or copper conductor (as applicable). The cable lugs shall suit the type of terminals provided. The cable lugs shall be of Dowell make or equivalent.

3.20 CONDUITS, PIPES AND ACCESSORIES

- 3.20.1** The Contractor shall supply and install all rigid conduits, mild steel pipes, flexible conduits, hume pipes, etc. including all necessary sundry materials, such as tees, elbows, check nuts, bushing reduces, enlargers, wooden plugs, coupling caps, nipples, gland sealing fittings, pull boxes, etc.
- 3.20.2** Rigid conduits shall be flow-coat metal conduits of Nagarjuna Coated Tubes or equivalent make. The outer surface of the conduits shall be coated with hot-dip zinc and chromate conversion coatings. The inner surface shall have silicone epoxy ester coating for easy cable pulling. Mild steel pipes shall be hot-dip galvanised. All rigid conduits/pipes shall be of a reputed make.
- 3.20.3** Flexible conduits shall be heat-resistant lead coated steel, water-leak, fire and rust proof, and be of PLICA make or equivalent.

3.21 MOTOR CONTROL CENTRE

- 3.21.1** The 415 Volt motor control centres (if provided separately) shall conform to the requirements for boxes/cabinets/kiosks. They shall be fixed type, shall be fully sectionalised and shall be equipped with load break switches. Motor feeders shall be provided with isolating switch fuse unit and Contractor with thermal overload relay and single phase protection. The motor Contractor shall have one normally open auxiliary contact for alarm purposes. The motor control circuit shall be independent from all other control circuits.
- 3.21.2** Isolating Switches
The incoming power supply isolating switch operation handle shall be interlocked

with the control cabinet door as to prevent opening of door when main switch is closed. Device for by passing the door interlock shall also be provided. Switch handle shall have provision for locking in both fully open and fully closed positions.

3.21.3 Fuses

All fuses shall be of the HRC cartridge type, conforming to IS:2208 and suitable to mount on plugin type of fuse bases. Fuses shall be provided with visible operation indicators to show that they have operated. All accessible live connections shall be adequately shrouded, and it shall be possible to change fuses with the circuit alive, without danger of contact with live conductor. Insulated fuse pulling handle shall be supplied with each control cabinet.

3.22 MOTORS

3.22.01 Motors shall be “Squirrel Cage” three phase induction motors of sufficient size capable of satisfactory operation for the application and duty as required for the driven equipment and shall conform to type tests and shall be subjected to routine tests as per applicable standards.

3.22.02 Enclosures

- a) For motors to be installed outdoor, the motor enclosure shall have degree of protection IP:55. For motors to be installed indoor, i.e. inside a box, the motor enclosure shall be dust proof equivalent to IP:44.
- b) Two independent earthing points shall be provided on opposite sides of the motor for bolted connection of earthing conductor.
- c) Motors shall have drain plugs so located that they will drain water resulting condensation or other causes from all pockets in the motor casing.
- d) Motors weighing more than 25 kg shall be provided with eyebolts, lugs or other means or facility for lifting.

3.22.03 Operational Features :

- a) Continuous motor ratings (name plate rating) shall be at least suitable for the driven equipment at design duty operating point of driven equipment that will arise in service.
- b) Motors shall be capable of giving rated output without reduction in the expected life span when operated continuously in the given system.

3.22.04 Starting Requirements

- a) All induction motors shall be suitable for full voltage direct on-line starting. These shall be capable of starting and accelerating to the rated speed alongwith the driven equipment without exceeding the acceptable winding temperature even when the supply voltage drops.
- b) Motors shall be capable of withstanding the electrodynamic stresses and heating imposed if it is started at a voltage of 110% of the rated value.
- c) The locked rotor current shall not exceed six(6) times the rated full load current for all motors subject to tolerance given in IS:325.
- d) Motors when started with driven equipment imposing full starting torque and supply voltage conditions specified shall be capable of withstanding at least two successive starts from cold condition at room temperature and one start from hot condition without injurious heating of winding. The motors shall also be suitable for

three equally spread starts per hour under the above referred supply condition.

- e) The locked rotor withstand time under hot condition at 110% of rated voltage shall be more than starting time with the driven equipment of minimum permissible voltage by a least two seconds or 15% of the accelerating time whichever is greater. In case it is not possible to meet the above requirement, the Contractor shall offer centrifugal type speed switch mounted on the motor shaft which shall remain closed for speeds lower than 20% and open for speeds above 20% of the rated. The speed switch shall be capable of withstanding 120% of the rated speed in either directions of rotation.

3.22.05 The maximum permissible temperature rise over the ambient temperature shall be within the limits specified in IS:325 (for 3 phase induction motors) after adjustment due to increased ambient temperature specified.

3.22.06 The double amplitude of motor vibration shall be within the limits specified in IS:729. Vibration shall also be within the limits specified by the relevant standard for the driven equipment when measured at the motor bearings.

3.22.07 All the induction motors shall be capable of running at 80% of rated voltage for a period of 5 minutes.

3.23 AUXILIARY SWITCH

The auxiliary switch shall conform of following type tests:

- a) Electrical endurance test - A minimum of 1000 operations for 2A. D.C. with a time constant greater than or equal to 20 milliseconds with a subsequent examination of mV drop/ visual defects/ temperature rise test.
- b) Mechanical endurance test - A minimum of 5000 operations with a subsequent checking of contact pressure test/ visual examination
- c) Heat run test on contacts
- d) IR/HV test, etc.

3.24 LAMPS AND SOCKETS

3.24.1 Lamps:

All incandescent lamps shall use a socket base as per IS-1258, except in the case of signal lamps.

3.24.2 Sockets

All sockets (convenience outlets) shall be suitable to accept both 5 Amp & 15 Amp pin round Standard Indian plugs. They shall be switched sockets with shutters.

3.24.3 Hand Lamp:

A 240 Volts, single Phase, 50 Hz AC plug point shall be provided in the interior of each cubicle with ON-OFF Switch for connection of hand lamps.

3.24.4 Switches and Fuses:

Each control panel shall be provided with necessary arrangements for receiving, distributing, isolating and fusing of DC and AC supplies for various control, signalling, lighting and space heater circuits. The incoming and sub-circuits shall be separately

provided with switch-fuse units. Selection of the main and sub-circuit fuse ratings shall be such as to ensure selective clearance of sub-circuit faults. Potential circuits for relaying and metering shall be protected by HRC fuses.

All fuses shall be of HRC cartridge type conforming to IS 9228 mounted on plug-in type fuse bases. Miniature circuit breakers with thermal Protection and alarm contacts will also be accepted. All accessible live connection to fuse bases shall be adequately shrouded. Fuses shall have operation indicators for indicating blown fuse condition. Fuse carrier base shall have imprints of the fuse rating and voltage.

All control switches shall be of rotary type. Toggle/piano switches shall not be accepted.

3.25 BUSHINGS, HOLLOW COLUMN INSULATORS, SUPPORT INSULATORS

3.25.1 Bushings shall be manufactured and tested in accordance with IS:2099 & IEC:137 while hollow column insulators shall be manufactured and tested in accordance with IEC 233/IS 5284. The support insulators shall be manufactured and tested as per IS:2544 / IEC 168/IEC 273. The insulators shall also conform to IEC 815 as applicable.

Support insulators/ bushings/ hollow column insulators shall be designed to have ample insulation, mechanical strength and rigidity for the conditions under which they will be used.

3.25.2 Porcelain used shall be homogenous, free from laminations, cavities and other flaws or imperfections that might affect the mechanical or dielectric quality and shall be thoroughly vitrified, tough and impervious to moisture. Hollow porcelain should be in one integral piece in green & fired stage.

3.25.3 Glazing of the porcelain shall be uniform brown in colour, free from blisters, burns and other similar defects.

3.25.4 When operating at normal rated voltage there shall be no electric discharge between conductor and insulators which would cause corrosion or injury to conductors or when operating at normal rated voltage.

3.25.5 The design of the insulator shall be such that stresses due to expansion and contraction in any part of the insulator shall be lead to deterioration. All ferrous parts shall be hot dip galvanised.

3.25.6 Contractor shall make available data on all the essential features of design including the method of assembly of shells and metal parts, number of shells per insulator, the manner in which mechanical stresses are transmitted through shells to adjacent parts, provision for meeting expansion stresses, results of corona and thermal shock tests, recommended working strength and any special design or arrangement employed to increase life under service conditions.

3.25.7 Post type insulators shall consist of a porcelain part permanently secured in metal base to be mounted on supporting structures. They shall be capable of being mounted upright. They shall be designed to withstand all shocks to which they may be subjected to during operation of the associated equipment.

3.25.8 Bushing porcelain shall be robust and capable of withstanding the internal pressures likely to occur in service. The design and location of clamps, the shape and the strength of the porcelain flange securing the bushing to the tank shall be such that there is no risk of fracture. All portions of the assembled porcelain enclosures and supports other than gaskets, which may in any way be exposed to the atmosphere shall be composed of completely non hygroscopic material such as metal or glazed porcelain.

3.25.9 All iron parts shall be hot dip galvanised and all joints shall be air tight. Surface of joints shall be trued; porcelain parts by grinding and metal parts by machining. Insulator/ bushing design shall be such as to ensure a uniform compressive pressure on the joints.

3.25.10 Bushings, hollow column insulators and support insulators shall conform to type tests and shall be subjected to routine tests and acceptance test/ sample test in accordance with relevant standards.

3.25.11 Insulator shall also meet requirement of IEC - 815 as applicable, having alternate long & short sheds.

3.26 CORONA AND RIV TESTS AND SEISMIC WITHSTAND TEST:

The corona (for 400kV only) and RIV tests shall confirm to the requirements as per **Annexure A** to this chapter. The seismic withstand test for 400kV shall conform to requirements as per **Annexure B** to this chapter.

3.27 Enclosures:

1. Annexure- A - CORONA AND RADIO INTERFERENCE VOLTAGE (RIV) TEST
2. Annexure- B - SEISMIC WITHSTAND TEST

Clause No.	TECHNICAL REQUIREMENTS			
	Annexure – A CORONA AND RADIO INTERFERENCE VOLTAGE (RIV) TEST 1.0 General Unless otherwise stipulated, all equipment together with its associated connectors where applicable shall be tested for external corona both by observing the voltage level for the extinction of visible corona under falling power frequency voltage and measurement of radio interference voltage (RIV). 2.0 Test Levels The test voltage levels for measurement of external RIV and for corona extinction voltage are listed under the relevant clauses of the specification. 3.0 Test Methods for RIV: 3.1 RIV tests shall be made according to measuring circuit as per International Special – committee on Radio Interference (CISPR) Publication 16 -1 (1993) Part – I. The measuring circuit shall preferably be tuned to frequency with 10 % of 0.5 MHz but other frequencies in the range of 0.5 MHZ to 2 MHz may be used, the measuring frequency being recorded. The result shall be in microvolts. 3.2 Alternatively, RIV tests shall be in accordance with NEMA standard Publication No. 107 – 1964 except otherwise noted herein. 3.3 In measurement of RIV temporary additional external corona shielding may be provided. In measurement of RIV only standard fittings of identical type supplied with the equipment and a simulation of the connections as used in the actual installation will be permitted in the vicinity within 3.5 meters of terminals. 3.4 Ambient noise shall be measured before and after each series of tests to ensure that there is no variation in ambient noise level. If variation is present, the lowest ambient noise level will form basis for the measurements. RIV levels shall be measured at increasing and decreasing voltages of 85% , 100%, 115% and 130% for the specified RIV test voltage for all equipment unless otherwise specified. The specified RIV test voltage for 420 KV is listed in the detailed specification together with maximum permissible RIV level in microvolts. 3.5 The metering instruments shall be as per CISPR recommendations or equivalent device so long as it has been used by other testing authorities.			
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Clause No.	TECHNICAL REQUIREMENTS 			
3.6	The RIV measurement may be made with a noise meter. A calibration procedure of the frequency to which noise meter shall be tuned shall establish the ratio of voltage at the high voltage terminal to the voltage read by the noise meter.			
4.0	Test Methods for visible Corona The purpose of this test is to determine the corona extinction voltage of the apparatus, connectors etc. The test shall be carried out in the same manner as RIV test described above with the exception that RIV measurements are not required during test and a search technique shall be used near the onset and extinction voltage, when the test voltage is raised and lowered to determine their precise values. The test voltage shall be raised to 130 % of RIV test voltage and maintained there for five minutes. In case corona inception does not take place at 130 %, the voltage level shall be raised till inception of corona or rated voltage whichever is lower. The voltage will then be decreased slowly until all visible corona disappears. The test procedure shall be repeated at least 4 times with corona inception and extinction voltage recorded each time. The corona extinction voltage for purposes of determining compliance with the specification shall be the lowest of the four values at which the visible corona (negative or positive polarity) disappears. Photographs with laboratory in complete darkness shall be taken under test conditions at all voltage steps i.e. 85%,100%,115% and 130%.Additional photographs shall be taken at corona inception and extinction voltages. At least two views shall be photographed in each case using Panchromatic film with an ASA daylight rating of 400 with an exposure of two minutes at a lens aperture of f / 5.6 or equivalent. The photographic procedure shall be such that prints are available for inspection and comparison with conditions as determined from direct observation. Photographs shall be taken from above and below the level of connectors so as to show corona on bushing, insulators and all parts of energized connectors. The photographs shall be framed such that test object essentially fills the frame with no cut off. 4.1 For recording purposes, modern devices using UV recording methods such as image intensifier may also be used. 4.2 The test shall be recorded on each photograph. Additional photograph shall be taken from each camera position with lights on to show the relative position of test object to facilitate precise corona location from the photographic evidence. 4.3 In addition to photographs of the test object preferably four photographs shall be taken of the complete test assembly showing relative positions of the test equipment and test object. These four photographs shall be taken from four points equally spaced around the test arrangement to show its features from all sides. Drawings of the laboratory and test set up locations shall be provided to indicate camera positions and angles. The precise location of camera shall be approved by			
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Clause No.	TECHNICAL REQUIREMENTS	
4.4	purchaser's inspector after determining the best camera locations by trial energisation of test object at a voltage which results in corona. The test to determine the visible corona extinction voltage need not be carried out simultaneously with test to determine RIV levels.	
4.5	However both tests shall be carried out with the same test set up and as little time duration between tests as possible. No modification or treatment of the sample between tests will be allowed. Simultaneous RIV and visible corona extinction voltage testing may be permitted at the discretion of the owner's engineer, if in his opinion it will not prejudice other test.	
5.0	Test Records: In addition to the information previously mentioned and requirements specified as per CISPR or NEMA 107-1964 the following data shall be included in the test report- a) Background noise before and after the test b) Detailed procedure of application of test voltage c) Measurement of RIV levels expressed in microvolts at each level. d) Results and observations with regard to location and type of interference sources detected at each step. e) Test voltage shall be recorded when measured RIV passes through 100 micro volt in each direction. f) Onset and extinction of visible corona for each of the four tests required shall be recorded.	
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Clause No.	TECHNICAL REQUIREMENTS	
	Annexure – B SEISMIC WITHSTAND TEST (For 400kV Only) The seismic withstand test on the complete equipment (except BPI) shall be carried out along with supporting structure. The bidder shall arrange to transport the structure from his contractor's premises / owner's sites for purpose of seismic withstand test only. The seismic level specified shall be applied at the base of the structure. The accelerometers shall be provided at the terminal pad of the equipment and at any other point as agreed by the owner. The seismic test shall be carried out in all possible combinations of the equipment. The seismic test procedure shall be furnished for approval of the purchaser.	
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SECTION - 4

GUARANTEED TECHNICAL PARTICULARS

CLAUSE NO.	BIDDER'S NAME	
	E-11	
	POWER AND CONTROL CABLES	
	(The following technical data shall be submitted by the Bidder for each type and size of the cable)	
	1. Maker's Name & country of Manufacturer	
	2. Manufacturer's type & designation	
	3. Applicable Standard	
	4. Rated Voltage (Volts)	
	5. Conductor	
	a) Material (Copper or aluminium)	
	b) Grade	
	c) Normal cross section area (Sq. mm)	
	d) Number and diameter	
	6. Insulation	
	Nominal thickness of insulation (mm)	
	7. Inner Sheath	
	a) Material	
	b) Thickness of sheath	
	c) Tolerance on thickness of inner sheath	
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CHAPTER-E 11 PART-A		
PAGE 1		

CLAUSE NO.	BIDDER'S NAME						
	8. Armour Type and material of armour						
	9. Outer Sheath a) Material c) Thickness of sheath						
	10. Test Voltage a) High Voltage test (kV) b) Water immersion test voltage (kV)						
<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 33%; text-align: center;"> NABINAGAR STPP (3X660MW) 400/132kV SWITCHYARD PACKAGE </td> <td style="width: 25%; text-align: center;"> ATTACHMENT 12 TO SECTION VII </td> <td style="width: 25%; text-align: center;"> CHAPTER-E11 PART-A </td> <td style="width: 17%; text-align: center;"> PAGE 2 </td> </tr> </table>				NABINAGAR STPP (3X660MW) 400/132kV SWITCHYARD PACKAGE	ATTACHMENT 12 TO SECTION VII	CHAPTER-E11 PART-A	PAGE 2
NABINAGAR STPP (3X660MW) 400/132kV SWITCHYARD PACKAGE	ATTACHMENT 12 TO SECTION VII	CHAPTER-E11 PART-A	PAGE 2				

Project: 400/132 kV Switchyard Package at
Nabinagar Super Thermal Power Project (3 X 660 MW)
Customer: Nabinagar Power Generating Co. Pvt.
Limited (NPGC)
Consultant: -----
Technical Specification: 1.1 kV Aux Power & Control Cables

Bharat Heavy Electricals Limited
Document No. TB 350 510 020B

SECTION-5

CHECK LIST FOR INFORMATION TO BE FURNISHED WITH OFFER RETURN THIS CHECKLIST AS PART OF THE OFFER DULY SIGNED

The offer may not be considered if the following information and this Checklist are not enclosed with the Offer.

BHEL ENQUIRY. NO:

BIDDER OFFER REFERENCE:

A)

(1) S.No.	(2) Parameters	(3) Data	(4) Yes / No	(5) Remarks in case reply in Col (4) is NO
1.0	Applicable Standard	Latest IS -1554, 5831, 8130, 7098, 3975, 613, ASTM-D2843, ASTM-D2863, IEC60754, IEC60332, IS3961, IS 10418, SS4241475, NEMA WC-70, IEEE-383; For screened cables, standards mentioned in Annexure-1B, Section-1.		
2.0	Type	FRLS		
3.0	Construction feature for PVC Control and Aux Power cable			
3.1a	Material of Conductor for Control cables	Plain Annealed, High Conductivity, Stranded, untinned Copper, Grade EC		
3.1b	Material of Conductor for Screened Cable	High Conductivity, Annealed bare copper, Electrolytic grade, Strands: 7x0.3mm (nom)		
3.2	Material of Conductor for Power cables	Stranded Aluminium, Grade H2 /H4		
3.3	Conductor Insulation for Control and Power cables	As per Annexure-1A, Section-1		
3.4a	Conductor insulation for Screened Control Cable	PVC Type Y13 (Insulation Thickness suitable for 1.1kV Voltage class as per relevant standards)		

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**Bharat Heavy Electricals Limited
Document No. TB 350 510 020B**

Consultant: -----

Technical Specification: 1.1 kV Aux Power & Control Cables

(1)	(2)	(3)	(4)	(5)
S.No.	Parameters	Data	Yes / No	Remarks in case reply in Col (4) is NO
3.4b	Shielding for Screened Control Cable	Al- Mylar Tape a) Individual Pair Shielding: 28 Micron Thickness (Min.) b) Overall cable assembly Shielding : 55micron Thickness (min)		
3.4c	Drain Wire for Screened Control Cable	For individual & Overall Shield: 7 Strand, 20 AWG (0.51sq.mm) annealed Tin coated copper		
3.5	Inner sheath	Extruded PVC, Type ST-1		
3.6a	Armouring for Control Cables	Galvanised Steel Round wire /formed wire for multicore cables		
3.6b	Armouring for Screened Control Cable	Galvanised Steel Round wire		
3.7	Armouring for Aux Power Cables	Aluminium round wire for Single core And Galvanised Steel round wire/formed wire for Multi-core cables		
3.8a	Outer sheath for Control and Power cables	PVC extruded, FRLS, Type ST-2, Category C2		
3.8b	Outer sheath for Screened Control Cable	PVC extruded, FRLS, Compound YM1		
4.0	Construction feature for XLPE Aux Power cable			
4.1	Material of Conductor for Power cables	Stranded Aluminium, Grade H2 /H4		
4.2	Conductor Insulation	XLPE		
4.3	Inner sheath	Extruded PVC, Type-ST2		

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Consultant: -----

Technical Specification: 1.1 kV Aux Power & Control Cables

(1)	(2)	(3)	(4)	(5)
S.No.	Parameters	Data	Yes / No	Remarks in case reply in Col (4) is NO
4.4	Armouring for Aux Power Cables	Aluminium round wire for Single core And Galvanised Steel round wire/formed wire for Multi-core cables		
4.5	Outer sheath	PVC extruded, FRLS, Type ST-2, Category C2		
5.0	FRLS properties of Outer sheath			
5.1	Minimum Oxygen index	29		
5.2	Minimum Temperature index	250°C		
5.3	Acid gas emission	Max 20% by weight		
5.4	Smoke density rating	Max 60%		
6.0	Tolerance on overall diameter	± 2mm		
7.0	Chemicals added to outer sheath to protect from rodent, vermin and termite attack	Yes		
8.0	Drum lengths shall be 1000m for cables with conductor cross section area less than 300 sq mm	Yes		
9.0	Tolerance on total quantity	± 2%		
10.0	Minimum bending radius for multicore cables	12 x D		

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Consultant: -----

Technical Specification: 1.1 kV Aux Power & Control Cables

(1) S.No.	(2) Parameters	(3) Data	(4) Yes / No	(5) Remarks in case reply in Col (4) is NO
11.0	Core Identification	By colour coding as per IS 1554 (Part-I)/ IS 7098 Part-I for the cables upto five (5) cores; and for the cables with more than five (5) cores, by printing legible Hindu Arabic numerals on all cores as per Clause 10.3 of IS 1554 (Part-1).		
12.0	The fillers and inner sheaths shall be of non-hygroscopic, fire retardant material, shall be softer than insulation and outer sheath shall be suitable for the operating temperature of the cable	Yes		

B) TYPE TESTS

i) Whether valid type test reports of all the tests as per relevant IS including additional tests mentioned in this specification, conducted earlier on identical material are available (test reports shall be of the tests conducted not earlier than 10 (ten) years prior to the date of bid opening). **(YES/NO)**

ii) If valid type test reports are not available with bidder / test reports are not acceptable to BHEL/Customer, then above tests shall be conducted by the bidder free of cost either at third party lab or in presence of BHEL/NTPC representative and submit the reports for approval. **(YES)**

C)

(1) S.No.	(2) Description	(3) Confirmation of Supplier
1.	Bidder to confirm that at all drawings / data sheets/QP/ valid type tests reports/ all relevant information shall be submitted to BHEL for organising approval of ultimate customer.	

Date:

Signature of the authorized representative of Bidder

Company Seal