

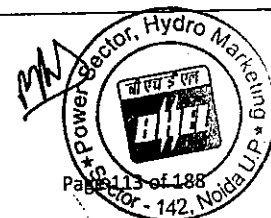
HT CABLES

pg.1 of 3

Attributes / Characteristics	Item / Components / Sub System Assembly	Make, Type, Rating & I.C	Dimension/surface finish	Mechanical properties	Chemical Composition	Spark Test(as applicable)	Curing Properties	Electrical properties	Hot Set Test/ Eccentricity & Ovality	Lay length & Sequence	Armour coverage, cross over, looseness, gap between two wire	Sequential marking/surface finish/ cable length	T.S & elongation before & after ageing on outer sheath & insulation	Thermal stability on outer sheath	Metallic (Cu) Screening (If applicable)	Anti termite coating on wooden drums	Constructional requirements feature as per THDC specification	Routine & Acceptance Test as per relevant standard & THDC specification	FRLS Test
Aluminium (IS-8130)		Y	Y	Y	Y			Y											
Semiconducting Compound		Y		Y			Y	Y											
XLPE Compound (IS-7098 Part-II)		Y		Y			Y	Y					Y						
FRLS PVC Compound (IS-5831, ASTM-D2843, IS10810(Part 58) ,IEC-60754 Part-1)		Y		Y									Y	Y					Y
Triple Extrusion & curing /Manufacturing of Core			Y			Y			Y	Y									
Copper Tape		Y	Y	Y				Y											
Polyster tape		Y	Y																
Armour wire/strip		Y	Y	Y															
Copper tapping		Y	Y					Y											
Inner sheath		Y	Y																
Armouring											Y				Y				
Outer Sheathing			Y									Y	Y	Y			Y	Y	Y
Power Cable (Finished) (IS : 7098 Part II, IEC : 60332 (Part 3 Cat. B), IS-5831, ASTM-D2843, IS10810(Part 58) , IEC-60754 Part-1)		Y								Y	Y	Y	Y	Y			Y	Y	Y
Wooden drum(IS-10418) / Steel Drum			Y													Y			
Notes: 1. This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents. 2. Make of all major Bought Out Items will be subject to THDC approval.																			



Section-29, VPH-EM Works-QAI Requirement



Page 113 of 188

Sector - 142, Noida U.P.

ROUTINE TESTS

Routine tests shall be carried out on each drum of finished cables for all types & sizes.

Following shall constitute routine tests:

1. Conductor Resistance test
2. High voltage test
3. Partial discharge test (for Screened cables only)

ACCEPTANCE TESTS

Following Acceptance tests shall be carried out for each type and size of the cables on the cable drums selected at random as per sampling plan mentioned in IS: 7098 Part 11

A) For Conductor

1. Tensile Test
2. Wrapping Test
3. Resistance test

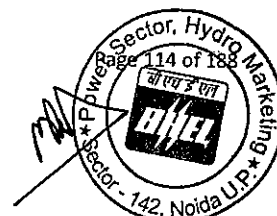
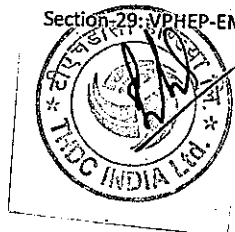
B) For Armour Wires / Formed Wires (If applicable)

1. Measurement of Dimensions
2. Tensile Tests
3. Elongation Test
4. Torsion Test For Round wires only
5. Wrapping Test
6. Resistance Test
7. Mass of Zinc coating test For G S wires / Formed wires only
8. Uniformity of Zinc coating For G S wires / Formed wires only
9. Adhesion test For G S wires / Formed wires only
10. Freedom from defects

C) For XLPE insulation & PVC Sheath

1. Test for thickness
2. Tensile strength & Elongation before ageing
3. Hot set test (For XLPE insulation)

Section-29: VPHEP-EM Works-QAI Requirement



HT CABLES pg3 of 3**D)****For completed cables**

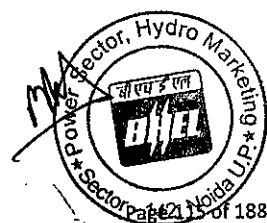
1. Insulation resistance test (Volume resistivity method)
2. High voltage test
3. Partial discharge test (for Screened cables only)

E)**Following tests shall be carried out and only one sample shall be taken from each offered lot of all sizes for these tests:-**

1. Tensile strength & elongation after ageing on XLPE insulation and PVC outer sheath
2. Thermal stability test on outer sheath
3. Oxygen index test on outer sheath
4. Smoke density rating test on outer sheath as per ASTM -D 2843
5. Acid gas generation test on outer sheath as per IEC - 60754 (Part 1)
6. Flammability test as per IEC-60332 - Part- 3 (Category- B) on completed cable

F)**Following tests shall be carried on one length of each size of offered lot:**

- 1) Surface finish, length measurement, sequence of cores, armour coverage, Gap between two consecutive armour wires / formed wires
- 2) Measurement of Eccentricity & Ovality

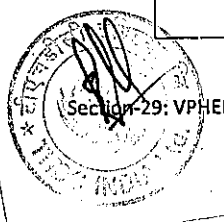


DC SYSTEM

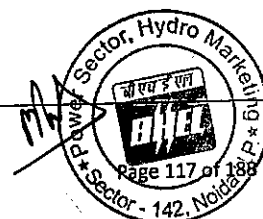
pg.1 of 3

A. LEAD ACID BATTERY								
ATTRIBUTES / CHARACTERISTICS → ↓ ITEMS, COMPONENTS, SUB SYSTEM ASSEMBLY	Dimensions & Finish	Conformance to relevant part drg. & Manufacturer's standards	Chemical composition	Lead Coating Thickness (min. 25 microns, IS: 6848 App.F) & Adhesion Check	Conformance to CPWD Spec. for Steel Rack.	Paint Process checks, Paint Shade, Thickness, Adhesion & Finish	Constructional requirements as per THDC Spec.	Routine & acceptance tests as per relevant standard
Container & Lids (IS : 1146)	Y	Y						
Vent Plugs	Y	Y						
Sealing Compound (IS : 3116)		Y	Y					
Positive & Negative Plates		Y	Y					
Separators (IS : 6071)	Y	Y						
Electrolyte (Water /Sulphuric Acid) (IS : 1069 / 266)		Y	Y					
Inter-cell Connectors & Fasteners	Y	Y		Y				
Battery Stand	Y	Y			Y	Y		
Cell Insulators	Y	Y						
Stack Assembly	Y	Y						
Lead Acid Battery (IS : 1652)	Y						Y	Y

Note: This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.



Section-29: VPHEP-EM Works-QAI Requirement



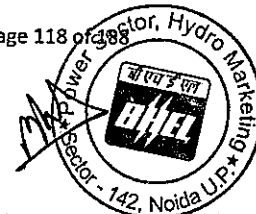
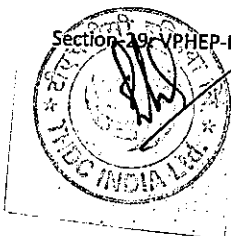
DC SYSTEM : BATTERY CHARGER		pg.2 of 3													
Attributes / Characteristics	Items / Components / Sub- assembly														
		Make, Model, Type, Rating & Finish	Verification of Routine test reports as per relevant IS	Sheet Steel Pretreatment & Painting process checks	Conform to relevant Standard & THDC spec	Dimensional check and Paint shade, thickness, adhesion & Finish checks	Complete physical examination for constructional features as per THDC approved drgs & specification	Temperature Rise Test on one unit of each rating if Type testing is waived off	Ripple Content Test, Load Limiter & AVR Operation Test	Dynamic Response Test	Operational & Functional Checks	HV & IR Test	Burn-In Test at 50°C for 48 hrs in energised condition	Alternating current measurement test	Degree of Protection Test as per THDC Spec.
	Rectifier Transformer and Reactors IS : 4540, 2026)	Y	Y		Y			Y				Y			
	Electronic Components including Potentiometer (Vernier Type)	Y			Y		Y								
	Electronic Cards	Y			Y								Y		
	PCB & racks for electronic cards	Y					Y								
	Control & Selector Switches (IS : 6875)	Y			Y						Y				
	Indicating Meters (IS : 1248)	Y			Y						Y				
	Indicating Lamps (IS: 13947)	Y			Y						Y				
	Air Break Switches / Fuses (IS : 13947 / 13703)	Y			Y						Y				
	Control Terminal Blocks (IS : 13947)	Y			Y										
	Control Transformer (IS:12021)	Y			Y						Y				
	Push Buttons (IS : 4794)	Y			Y						Y				
	MCB (IS : 8828)	Y			Y						Y				
	PVC insulated Copper control wires (IS : 694)	Y			Y										
	Sheet Steel (IS : 513)	Y		Y	Y										
	Synthetic Rubber Gaskets	Y			Y										
	Annunciator	Y									Y		Y		
	Battery Charger	Y				Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Notes: 1. This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.															
2.Makes of all major Bought Out Items will be subject to THDC approval.															

Notes: 1. This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.

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Section-29-VPHEP-EM Works-QAI Requirement

Page 118 of 388



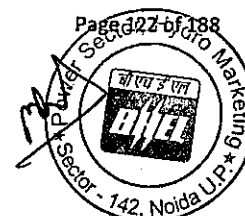
Section-29: V

CONTROL PANEL

Attributes Characteristics		Electrical Properties	Mechanical Properties	Chemical Properties	Dimensions / Finish	Type/ Rating/Functional check	HV/IR	Routine test as per relevant std.	Constructional Features	IS:6005 ,Seven tank process	Paint finish/ shade/thickness adhesion	Mountings / BOM/ Make, Completeness	Interlock Functional & Operation Testing /Simulation check	Degree of Protection Test	Specification requirement
Item Components	Sub System Assembly														
Sheet Steel (IS-513)		Y	Y	Y											
Aluminum / Copper Bus-bar (IS-5082/IS-613/IS-1987)		Y	Y	Y	Y										
Support Insulator (BS-2782/IEC-660/IS-10912)		Y	Y	Y	Y										
Control / Selector Switch (IS-6875)						Y	Y	Y							
Contractor/ MCB (IS-13947)						Y	Y	Y							
O/L Protection relays (IS-3231)						Y		Y							
C.T /V.T/ Indicating Meter (IS-2705/3156/1248)						Y	Y	Y							
Fuse/ Fuse carrier (IS-13703)						Y	Y	Y							
Terminals/lugs/pvc wires (IS-13947//IS-694)	Y			Y	Y	Y	Y								
Timers (IS-3231)						Y	Y	Y							
LVS, Mosaics															Y
Push Button/ Lamp/ (IS-6875)						Y	Y	Y							
Control Transformer (IS-12021)						Y	Y	Y							
Mimic, Annunciater					Y		Y								
GASKET (IS-11149)		Y	Y	Y	Y		Y								
Fabrication								Y							
Pretreatment & Painting									Y	Y					
Control panel										Y	Y	Y	Y	Y	Y

NOTE:

1. This is an indicative list of Test/ Checks. The manufacturer to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.
2. All major Bought out Items will be subject to OWNER approval.
3. Any other tests mentioned else where in technical specification are also to be carried out. The codes and standards mentioned in Technical specification is governing



CABLING, EARTHING, LIGHTNING PROTECTION

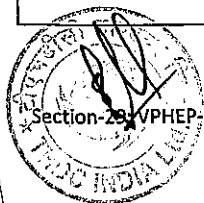
ATTRIBUTES / CHARACTERISTICS														
ITEMS/COMPONENTS / SUB SYSTEMS	Dimension	Paint shade, paint thickness, adhesion	Pre-treatment of sheet	IP protection	Proof load*	Surface finish	Deflection test*	HV & IR	Galvanize Test (If Applicable)	Functional	Bought out items/Bill of material	Routine tests as per relevant standard & specification	Acceptance tests as per relevant standard & specification	Constructional feature as per THDC Specification
Wall Mounted-Lighting Panel (IS-513, IS:5, IS:2629, 2633, 6745)	Y	Y	Y	Y		Y		Y	Y	Y	Y	Y	Y	Y
Switch box/junction box/ Receptacles Panel (IS-513, IS:5, IS:2629, 2633, 6745)	Y	Y	Y	Y		Y		Y	Y	Y	Y	Y	Y	Y
Cable glands(BS-6121)	Y											Y		
Cable lug(IS-8309)	Y											Y		
Lighting wire(IS-694)	Y											Y		
Flexible conduits	Y											Y		Y
Conduits(Galvanise & Epoxy) IS-9537 & IS-2629,2633 ,6745	Y		Y								Y	Y		Y
RCC Hume Pipe (IS-458)												Y		
Cable termination & straight through joint (VDE-0278)	Y											Y		Y
Cable Trays, Flexible supports system & accessories IS-513, 2629,2633,6745	Y		Y		Y	Y	Y	Y	Y	Y		Y	Y	Y
Trefoil clamp	Y													Y
GI flats for earthing & lighting protection (IS 2062, 2629, 6745,2633)	Y		Y						Y			Y		Y
GI wire (IS-280)	Y											Y		
Fire Sealing System (BS -476)												Y	Y	Y

Note:1.This is an indicative list of tests /checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.

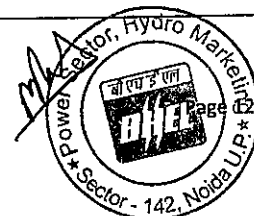
2.* Deflection Test on cable trays and Proof Load test on cable trays support system will be as per details given in the THDC technical specification & approved MQP. The above acceptance tests shall be done only on one sample from each size of offered lot.

3. Make of all items will be subject to OWNER's approval.)

4. Any other tests mentioned else where in technical specification are also to be carried out. The codes and standards mentioned in Technical specification is governing



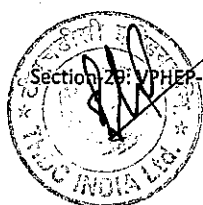
Section-29, VPHEP-EM Works-QAI Requirement



Page 123 of 188

QA&I: Vishnugad-Pipalkoti HEP (4x111 MW)

Control & Instrumentation Works



Section 29: VPHEP-EM Works-QAI Requirement



Page 124 of 188

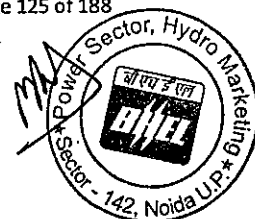
QA& I REQUIREMENTS: C&I WORKS

Sl.No.	Item/ Equipment	Page No.
~~1~~	~~Control & Instrumentation (C&I) – General Requirements~~	~~126 – 131~~
~~2~~	~~Supervisory Control and Data Acquisition System (SCADA)~~	~~132 – 134~~
~~3~~	~~Hydro Turbine Related Specific Instrumentation and Control~~	~~135~~
4	Control Desk, PLC Panel, Smoke Detector, Fire Alarm Control Panel	136
5	Battery Charger	137
6	Power Supply System	138
7	Instrumentation Cable	139
~~8~~	~~Closed Circuit Television System (CCTV)~~	~~140~~
9	Measuring Instruments (Primary and Secondary)	141 – 142
~~10~~	~~Public Address System~~	~~143~~
11	Electrical Actuator with Integral Starter	144
~~12~~	~~Maintenance and Calibration Equipment~~	~~145~~



Section-29: VPHEP-EM Works-QAI Requirement

Page 125 of 188

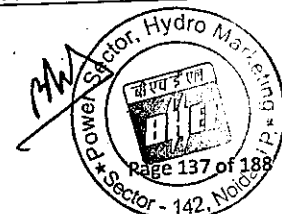


CONTROL DESK, PLC PANEL, SMOKE DETECTOR, FIRE ALARM CONTROL PANEL													
ITEMS	TESTS												
	Visual ®	GA, BOM, Lay Out of components ®	Dimensions ®	Paint Shade/Thickness/Adhesion ®	Alignment of Section ®	Component Rating/ Make / Type ®	Wiring ®	IR & HV ®	Review of TC for instruments/ Devices/ Recorders, Indicators/ osaic Items/ Transducers ®	Accessibility of TBS/ Devices ®	Illumination ®	Functional Check for Control Element, Annunciation ®	Mimic ®
1. Annunciation, Control, PLC Panel, Fire alarm panel	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y		Y
2. Smoke Detectors (UL-268, EN-54 PT-7), Heat Detectors (UL-521/ EN 54 PT-5) Annunciation/ Control Panel (UL -864, EN-54, PT-2)													Y
Note: 1) Detailed procedure of Burn-in and Elevated Temperature test shall be as per Quality Assurance Programme in General Technical Requirements 2) This is an indicative list of test/ checks. The manufacturer is to furnish a detailed quality plan indicating the Practice and Procedure alongwith relevant supporting documents. *Applicable for PLC - Y - Test Applicable , ® - Routine Test (A) - Acceptance Test													

BATTERY CHARGER										
Attributes / Characteristics →										
	↓ Items / Components / Sub-assembly									
	Make, Model, Type, Rating & Finish	Chemical & Mechanical Tests	Sheet Steel Pretreatment & Painting process checks	Conform to relevant Standard	Dimensional check and Paint shade, thickness, adhesion & Finish checks	Complete physical examination for constructional features of Battery Charger as per THDC specification	Temperature Rise Test	Dynamic Response Test	Ripple Content Test, Load Limiter & Annunciator & AVR Operation Test	Operational & Functional Checks
										HV & IR Test
										Burn-In Test at 50°C for 48 hrs
										Degree of Protection Test as per THDC Spec.
Rectifier Transformer (IS : 2026)	Y			Y			Y			Y
Electronic Components including Potentiometer (Vernier Type)	Y			Y						
PCB & Electronic Cards	Y			Y		Y				
19" standard racks for electronic cards	Y									
Control & Selector Switches (IS : 6875)	Y			Y					Y	
Indicating Meters (IS : 1248)	Y			Y					Y	
Indicating Lamps (IS: 13947)	Y			Y					Y	
Air Break Switches / Fuses (IS : 13947 / 13703)	Y			Y					Y	
Control Terminal Blocks (IS : 13947)	Y			Y					Y	
Control Transformer (IS : 12021)	Y			Y					Y	
Push Buttons (IS : 4794)	Y			Y					Y	
MCB (IS : 8828)	Y			Y						
PVC insulated Copper control wires (IS : 694)	Y			Y						
Sheet Steel (IS : 513)	Y	Y	Y	Y						
Synthetic Rubber Gaskets	Y	Y		Y					Y	Y
Annunciator	Y				Y	Y	Y	Y	Y	Y
Battery Charger	Y				Y	Y	Y	Y		Y
Notes: 1. Detailed procedure of Burn-in and Elevated Temperature test shall be as per Quality Assurance Programme in General Technical Requirements										
2. This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the Practice and procedure along with relevant supporting documents.										
3. Makes of all major Bought Out Items will be subject to THDC approval.										



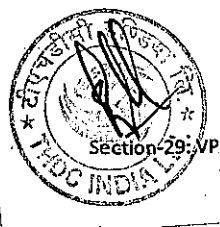
Section-29, VPH-EM Works-QAI Requirement



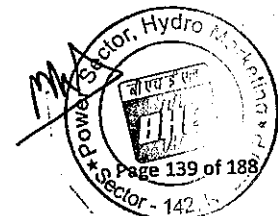
Page 137 of 188

Page 138 of 188

INSTRUMENTATION CABLE													
ITEMS	TESTS												
	Conductor Resistance @ & (A)	High Voltage @ & (A)	Insulation Resistance @ & (A)	Constructional detail, dimensions (A)	Outer-Sheath/core marking, end sealing (A)	Thermal Stability (A) +	Visual, Surface finish (A) +	Electrical Parameters ** (A) +	Persulphate Test (A) +	Overall/Coverage/Continuity (A)	Swidish chimney Test (SS-4241475) (A) ++	FRLS Test * (A) ++	Tensile & Elongation before & after aging (A)
1. Instrument cable twisted and shielded													
Conductor(IS-8130)	Y			Y			Y						Y
Insulation(VDE-207)				Y	Y	Y	Y						Y
Pairing/Twisting				Y	Y		Y			Y			
Shielding				Y			Y		Y	Y			
Drain wire	Y			Y			Y		Y	Y			
Inner Sheath				Y	Y	Y	Y					Y	Y
Outer Sheath				Y	Y	Y	Y					Y	Y
Over all cable	Y	Y	Y	Y	Y		Y	Y			Y		Y
Cable Drums(IS-10418)				Y			Y						
Note : High Temp. cables shall be subjected to tests as per VDE-207 (Part-6) Compensating cables shall be checked for Thermal EMF/Endurance test as per IS 8784. Note : This is an indicative list of tests/checks. The manufacture is to furnish a detailed Quality Plan indicating his practice & Procedure along with relevant supporting documents during QP finalization for all item. Note : @ - Routine Test A - Acceptance Test Y - Test Applicable Note : Sampling Plan for Acceptance test shall be as per IS 8784 (As applicable) * FRLS Tests: Oxygen / Temp Index (ASTM D-2863), Smoke Density Rating (ASTM - D 2843), HCL Emission (IEC-754-1) ** Characteristic Impedence, Attenuation, Mutual Capacitance, Cross Talk (As applicable) + Sample size will be One No. of each size/type per lot. ++ Sample size will be One No. sample for complete lot offered irrespective of size/type.													



Section-29: VPHEP-EM Works-QAI Requirement

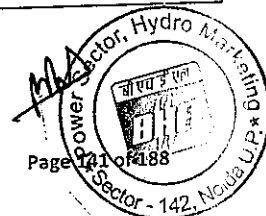


Page 139 of 188

MEASURING INSTRUMENTS (PRIMARY AND SECONDARY) pg1of2						
ITEMS	TESTS					
	Dimensions (R)	Make, Model, Type, Rating (R)	Process / Electrical connection (R)	Calibration (R)	Test as per standard (R)	Insulation Resistance (R)
1. PR Gauge (IS-3624)	Y	Y	Y	Y	Y	Y
2. Temp. Gauge (BS-5235)	Y	Y	Y	Y	Y	Y
3. Pr./D.P.Switch (BS-6134)	Y	Y	Y	Y	Y	Y
4. Electronic Transmitter (IEC-770)	Y	Y	Y	Y	Y	Y
5. Temp. Switch	Y	Y	Y	Y	Y	Y
6. Recorder (IS-9319/ANSI C-39.4)	Y	Y	Y	Y	Y	Y
7. Vertical indicators	Y	Y	Y	Y	Y	Y
8. Digital Indicators	Y	Y	Y	Y	Y	Y
9. Integrators	Y	Y	Y	Y	Y	Y
10. Electrical Metering Instrument (IS-1248)	Y	Y	Y	Y	Y	Y
11. Transducer (IEC-688)	Y	Y	Y	Y	Y	Y
12. Thermocouples (ANSI-MC-96.1)	Y	Y	Y	Y	Y	Y
13. RTD (IEC-751)	Y	Y	Y	Y	Y	Y
R-Routine Test A- Acceptance Test Y – Test applicable						
Note: 1) Detailed procedure of Burn-in and Elevated Temperature test shall be as per Quality Assurance Programme in General Technical Conditions 2) This is an indicative list of tests/checks. The manufacturer is to furnish a detailed quality plan indicating the Practices and Procedure adopted alongwith relevant supporting documents.						



Section-29: VPHEP-EM Works-QAI Requirement



Page 141 of 188

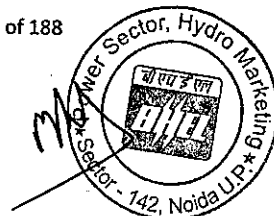
MEASURING INSTRUMENTS (PRIMARY AND SECONDARY) Pg2of2

ITEMS	TESTS										
	Dimensions (R)	Make, Model, Type, Rating (R)	Process / Electrical connection (R)	Calibration (R)	Requirement as per standard (R)	WPS approval (A)	Non-destructive testing (R)	Insulation Resistance (R)	IBR Certification as applicable (R)	Hydro test (R)	Material test certificate (A)
14. Thermowell									Y	Y	Y
15. Cold junction compensation box	Y	Y	Y	Y				Y			
16. Orifice plate (BS-1042)	Y	Y	Y	Y*	Y	Y**	Y**		Y	Y*	Y
17. Flow nozzle (BS-1042)	Y	Y	Y	Y*	Y	Y	Y		Y	Y	Y
18. Level transmitter/ switch	Y	Y	Y	Y				Y	Y	Y	Y
*Calibration to be carried out on one flow element of each type and size if calibration carried out as type test same shall not be repeated.											
** If applicable											
R-Routine Test A- Acceptance Test Y – Test applicable											
Note: 1) Detailed procedure of Burn-in and Elevated Temperature test shall be as per Quality Assurance Programme in General Technical Conditions 2) This is an indicative list of tests/checks. The manufacturer is to furnish a detailed quality plan indicating the Practices and Procedure adopted alongwith relevant supporting documents.											



Section 29: VPHEP-EM Works-QAI Requirement

Page 142 of 188



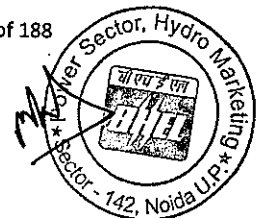
ELECTRICAL ACTUATOR WITH INTEGRAL STARTER

ITEM/ COMPONENT/ SUB SYSTEM ASSEMBLY/ TESTING	Test/Attributes Characteristics											
	RPM ®	No Load Current ®	IR & HV Test®	Mounting Dimension®	All routine Test as per Standard & Specification®	Correct Phase Sequence®	Operation & Setting of limit Switch/Torque Switch®	Stall Torque/Current (A)	Hand Wheel operation/ Auto de clutch function (A)	Function of Aux. like Potentiometer, space heater, position indicator ®	EPT output ®	Grease leakage ®
ELECTRICAL ACTUATOR WITH INTEGRAL STARTER (IS-9334)												
Motor	Y	Y	Y	Y	Y							
Final Testing	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Note: 1) Detailed procedure of Burn-in and Elevated Temperature test shall be as per Quality Assurance Programme in General Technical Requirements 2) This is an indicative list of tests/checks. The manufacturer is to furnish a detailed quality plan indicating the practices and procedure adopted along with relevant supporting documents.												
® - Routine Test (A) - Acceptance Test Y - Test applicable												



Section-29, VPHEP-EM Works-QAI Requirement

Page 144 of 188



QA&I: Vishnugad-Pipalkoti HEP (4x111 MW)

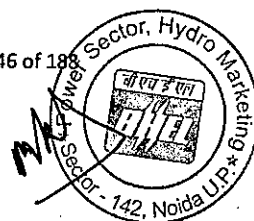
Mechanical Works

VISHNUGAD-PIPALKOTI HEP (4x111 MW)



Section 29: VPH-EM Works-QAI Requirement

Page 146 of 188



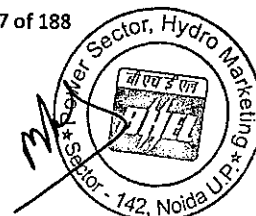
QA&I REQUIREMENTS: MECHANICAL WORKS

Sl.	Item/ Equipment	Page No.
1	Material Procurement and Manufacture	148 – 153
2	~~Appendix-I: Chart of Required Tests~~	~~154 – 157~~
3	~~Francis Turbine~~	~~155~~
4	~~Thrust and Guide Bearings~~	~~156~~
5	~~Penstock & Steel Lining~~	~~156~~
6	~~MIV/ Spherical / Butterfly Valves, Pressure Vessel~~	~~157~~
7	~~Appendix-II: Forged Parts~~	~~158 – 159~~
8	Appendix-III: Tests at Works	
	Assembly Inspection: Turbine, Spherical Valve, Governing System, Cooling Water System/ Drainage-Dewatering System/ Compressed Air System	160
	Pressure Test/ Dielectric Test/ Other Tests: Turbine, Spherical Valve, Governing System, Cooling Water System/ Drainage-Dewatering System/ Compressed Air System	161 – 162
	Operational Test: Turbine, Spherical Valve, Governing System, Cooling Water System/ Drainage-Dewatering System/ Compressed Air System	163 – 164
9	~~E.O.T. Cranes~~	~~165 – 166~~
10	~~Fire Protection System~~	~~166 – 170~~
11	AC System	171 – 175
12	Ventilation System	176 – 177
13	~~Compressor Air System~~	~~178 – 179~~
14	HOT Crane	180
15	Centrifugal Pumps: Piping, Valves, & Fitting and Painting	181 – 183
16	~~Cooling Water System~~	~~184 – 187~~
17	~~Equipment- Cooling Water System~~	~~188~~



Section-29, WPH-EM Works-QAI Requirement

Page 147 of 188



MATERIAL PROCUREMENT AND MANUFACTURE

1.00.0. SCOPE

This specification concerns the procurement materials and parts manufacturing methods (cutting, welding, etc.)

The minimum testing required from the Contractor is defined in the Appendix 1.

1.01.0. MATERIAL PROCURMENT

1.01.01 PROCUREMENT SPECIFICATIONS

The contractor shall submit material procure procedure.

For each part, the Contractor shall define the grade of materials and chemical composition compliance with the functions of the part and compatible with manufacturing conditions, unless specified in each detailed specification.

The Contractor shall provide the materials in compliance with the following standards:

Material	standard
Sheets	EN ,IS or equivalent
forging	EN, ASTM,IS or equivalent
casting	EN, ASTM, IS or equivalent

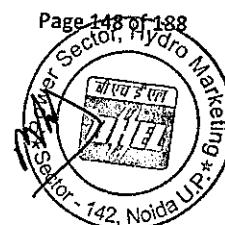
The following minimum thickness, unless otherwise specified, shall be observed for elements made of structural steels.

- Steel plate, flats: 8 mm
- Steel bar and sections, tubes: 6mm
- Embedded steel elements: 10mm

2.00.00. PROCUREMENT CONDITIONS

2.01.00. TESTS

The compulsory tests to be implemented (mechanical properties, inspections, etc.) shall be defined by the Contractor in a procurement specification in the form of a table indicating the type of tests to be performed, unless indicated detailed technical specifications.



2.02.00. FINAL DOCUMENTS

The identification of a part or product shall be ensured by individual marking. Traceability between the part or product and the acceptance inspection and test reports shall be ensured either individually or by batch, depending on stipulated acceptance conditions.

2.03.00. SUPPORTING DOCUMENTS FOR CHOICE OF MATERIALS

The contractor shall provide full technical support for his choice of materials for component procurement.

This support shall be based on analysis of all relevant data taken into account by the Contractor, in particular concerning design (dimension of parts), characteristics of the grades chosen, conditions for their treatment and implementation and equipment operating conditions.

3.00.00 MATERIAL INSPECTION

3.01.00. CHEMICAL COMPOSITION

The Contractor shall provide a description of the chemical composition specified and guaranteed for casting, forging and rolled products.

The Contractor shall provide chemical analysis of materials other than steel according to its classification of materials.

3.02.00. MANUFACTURING

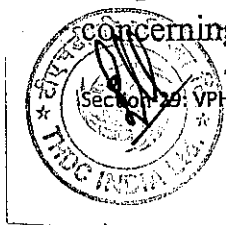
3.02.01. Technical Manufacturing Programme

The Contractor shall specify the required technical manufacturing programme.

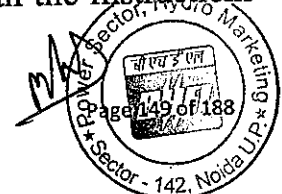
3.02.02. Delivery condition - heat treatment

The Contractor shall specify the delivery condition required for parts or products (thermally treated condition, pickling or aestivation operations, etc.)

The final quality heat treatment conditions shall be specified, in particular with the parameters of the cycles for this heat treatment, along with the instructions concerning temperature control.



Section 29: VPHEP-EM Works-QAI Requirement



3.03.00. MECHANICAL CHARACTERISTICS

3.03.01. Required Mechanical Characteristics

The Contractor shall list the mechanical characteristics specified and guaranteed, along with those also requested for information (including, if applicable, characteristics).

3.03.02. Instructions for taking samples

The Contractor shall specify the conditions under which samples shall be taken (condition of part or product, sample marking, etc) as well as the sampling procedures.

3.03.03. Tests to be performed:

The Contractor shall specify:

- Batch definition,
- Number and type of series of tests to be performed per batch,
- Test performance procedures,
- The conditions allowing parts or products to be reworked, specifying the amount of reworking authorized.

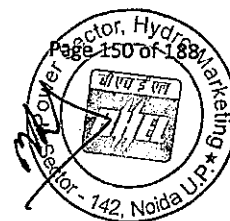
3.04.00. Non-Destructive Tests

The non-destructive tests shall be achieved in compliance with the following standards:

Material	ND test
sheets, rolled products	EN 10160 ^(#) or equivalent
forging	See Appendix-II
casting	CCH -70-3

(#): EN 10160 "Ultrasonic Testing of steel flat product of thickness equal or greater than 6 mm" (Dec-1999)

Section-29-VPHEP-EM Works-QAI Requirement



3.05.00. VISUAL INSPECTION

The contractor shall specify a procedure of visual inspection in accordance with admitted standard (ASME or equivalent) performed on the parts or products, with the scope of these tests and their associated acceptance criteria.

4.00.00. MANUFACTURE

4.01.00. IDENTIFICATION AND MARKING OF PRODUCTS AND PARTS

Products and parts to be used shall be marked for identification (e.g. equipped with permanent identification plates in readily visible locations). The inscription shall be printed, punched or engraved, and water-proof, oil-proof, and wear-resistant.

Equipment manufacture may begin only if the base materials to be used have been identified

The identification plates shall be protected during erection and especially during painting. Damaged identification plates shall be replaced by new ones.

Marking shall be performed in such a way that it shall not affect the materials behavior under normal operating conditions.

5.00.00. MANUFACTURING

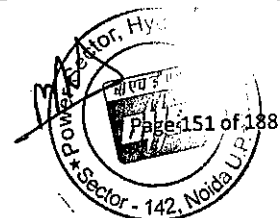
5.01.00. CUTTING

Mechanical or thermal cutting shall be used to achieve the required size. Eliminating the zone hardened by mechanical or thermal cutting shall not be required, if this zone is either melted or restored during welding.

The contractor shall examine the need to preheat prior to thermal cutting, according to grade of steel and thickness.



Section-29 VPHEP-EM Works-QAI Requirement



Page 151 of 188

5.02.00. ASSEMBLY

The Contractor shall verify, by preliminary tests or by applying the rules set out in engineering codes, that the parts mechanical characteristics (tensile strength, elongation, impact strength) have not been deteriorated by forming. if this cannot be proven conditioning heat treatment shall be applied.

5.02.01. Welding:

All welds shall comply in all respect with ASME or EN standard.

5.02.02. Mechanical Assembly:

All mechanical assembly operations shall be described in a procedure specifying:

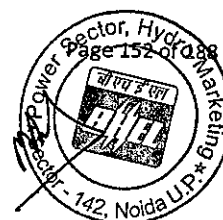
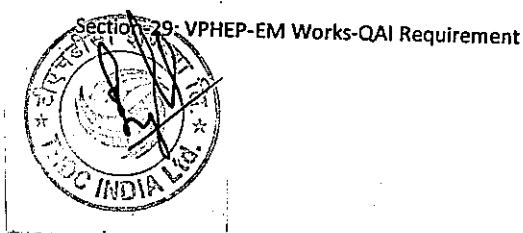
- The type of lubricant used,
- The required tightening torque or elongation value
- The required tightening sequence and type of tools.
- Alignment tolerance,
- Functional clearances
- The related dimensional inspections

The lubricants used shall be stable at operating temperature and compatible with the materials with which they are in contact.

If manufacture in operations are likely to bring foreign materials into tapped bore holes, the latter shall be plugged for protection.

6.00.00. SURFACE TREATMENT:

The Contractor shall respect the Gen. Tech. Requirements "Surface Treatment and Coatings" (see Annexure-A of B-QA&I Requirement for EM Equipment).



7.00.00. HYDROSTATIC TEST

Unless otherwise specified in TS, the Contractor shall undergo the following procedure:

Equipment under pressure shall undergo hydrostatic testing in the factory, except where previously agreed otherwise by the Contractor and the Employer.

Testing temperature shall be the normal operating temperature, and test pressure shall be 1.5 times the rated pressure or where there is a written waiver in the particular specifications.

The test shall last long enough to allow complete inspection of the parts under pressure. A hydrostatic test shall be considered satisfactory if neither leakage during testing nor significant permanent deformation after testing have been observed, with a minimum test time of 30 minutes. However, it may be necessary to increase test time for large thicknesses.

The Contractor shall prepare a report for every hydrostatic test. All pressure and tightness tests shall be performed prior to surface treatment.

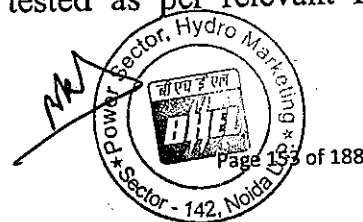
8.00.00. CLEANLINESS

During manufacturing, the Contractor shall take all the necessary measures to ensure that equipment is not contaminated by chemical products harmful to its withstand overtime.

Before packaging for shipping, equipment cleanliness shall be inspected according to the criteria defined above-mentioned. This cleanliness inspection shall be recorded in a report specifying the equipment, the inspection performed, and inspection results. If necessary, the equipment shall be re-cleaned and shall undergo a second cleanliness inspection before shipping.

9.00.00. Electrical items

Electrical items like motors, control panels, cables, resistances, switches, other control & protection devices shall be tested as per relevant IS Standards for their electrical characteristics.



APPENDIX-I

CHART OF REQUIRED TESTS

The **minimum** testing required from the Contractor is defined in the charts hereafter.

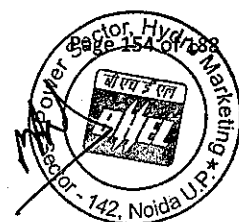
This document of required tests shall be confirmed and submitted by the Contractor to the Employer.

Meaning of symbols used in the chart

- C : Part or element manufactured by casting
 W: Part or element manufactured by welding
 F : Part or element manufactured by forging
 R : Part or element manufactured by rolling (laminated)
 S : Part or element manufactured with shrunk-on sheets (electrical devices)
 MC : Materials testing including verification of chemical composition and measurement of mechanical characteristics.
 HT : Verification of heat treatment (report). If no symbol appears, there may be heat treatment with no issuance of a report.
 VI : Volume inspection (radiography, ultrasonic testing)
 SI : Surface inspection (dye penetrant test, magnetic particle inspection)
 WS : Welding specifications
 VA: Visual assessment, surface state inspection (covers both the welding phase and the manufacturing phase complemented by a surface inspection in case of any doubt)
 HTI : Hydraulic test inspection

Notes :

- 1) All items to be manufactured as per approved drawings.
- 2) Dimensional check is to be carried out for all items/equipments.
- 3) When a volume check (VI) or surface check (SI) is required by the chart, but the nature of that check is not established, the Contractor shall propose the most suitable method.



2.00.00 INVESTIGATION OF INTERNAL DEFAULTS**2.01.00 Inspections to be performed**

Parts are examined by ultrasonic method before forming, according to conditions forecast in appendix 1. Inspection is performed according to arrangements of EN-10228 standard.

Scanning is carried out by a square pattern and dimensioning of indications is performed by the equivalent diameter method (longitudinal waves).

For hollow cylindrical parts belonging to 3a and 3b divisions, an inspection with transverse waves shall be carried out according to EN-10228 standard, using reference notch method.

The Contractor may avoid final check by ultrasonic method on parts manufactured with semi finished products which have undergone ultrasonic inspection during forming.

2.02.00 Acceptance criteria**2.02.01 Longitudinal waves**

The Contractor shall take into account criteria of quality class 2, except for trunnions, hoops, pinions, lifting hooks and transmission shafts where criteria of quality class 3 shall be applied.

2.02.02 Transverse waves

The Contractor shall apply criteria of EN-10228 standard.

2.02.03 Removal of damaged area

The Contractor shall remove only surface defaults, except for the compliance of dimensional tolerance limits of the part. After removal of defaults, the Contractor shall undergo an inspection by dye penetrant test or by magnetic particle.

Forged parts shall not be repaired by welding.



(Section 29: VPHEP-EM Works-QAI Requirement



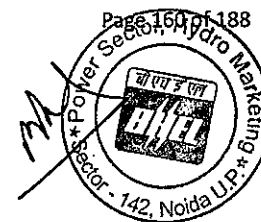
APPENDIX III : TESTS AT WORKSHOP

ASSEMBLY INSPECTION

No.	Components to be assembled	Assembly inspection	Remarks
TURBINE			
1.	Shaft and runner assembly	♦	Run out checks
2	Spiral casing	♦	
3	Stay ring	♦	
4	Wicket gate		
5	Top & bottom cover		
6	Turbine bearing		
7	Other stationary parts		
SPHERICAL/BUTTERFLY VALVE			
1.	Valve assembly	♦	
2.	Servomotor		
3.	Bye pass valve		
4.	Other valves		
GOVERNING SYSTEM			
1.	Actuator and Pilot Servomotor assembly & control	♦	
2.	Oil Sump tank		Assembly to be tested for leakage
COOLING WATER SYSTEM / DRAINAGE- DEWATERING SYSTEM/ COMPRESSED AIR SYSTEM:			
1.	Pumps / Compressors		
2.	Piping / Compressors		



Section-29: VPHEP-EM Works-QAI Requirement

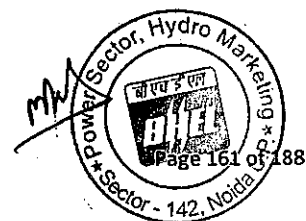


PRESSURE TEST / OTHER TESTS:

No.	Components	Hydraulic pressure test	Remarks
TURBINE:			
1.	BF valve servomotor	♦	Leakage test through piston seal and shaft seal Duration 30 minutes
2.	Spherical valve servomotor	♦	--do--
3.	Cooling coils for turbine bearing	♦	--do--
4.	Turbine bearing oil tank	♦	No leakage in one hour with light solvent filled
5.	Valves	♦	--do--
	(a) Body		All type of valves to be covered
	(b) Seat		
6.	Piping	♦	--do--
7.	Water /oil / air / piping	♦	--do--



Section-29 VPHEP-EM Works-QAI Requirement



SPHERICAL / BUTTERFLY VALVE:

No.	Components	Hydraulic pressure test	Remarks
1.	Body	♦	
2.	Seat	♦	
3.	Valves	♦	
	(a) Body		
	(b) Seat		
4.	Piping	♦	

GOVERNING SYSTEM

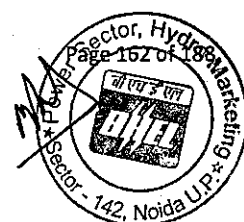
1.	Oil pressure tank for governor	♦	
2.	Air pressure tank for governor	♦	

COOLING WATER SYSTEM / DRAINAGE- DEWATERING SYSTEM / COMPRESSED AIR SYSTEM

No.	Components	Pressure test	Remarks
1.	Piping	♦	Duration 30 minutes
2.	Valves	♦	--do--
3.	Pumps	♦	--do--
4.	Compressors	♦	--do--
5.	Strainers	♦	--do--



Section 29: VPHEP-EM Works-QAI Requirement

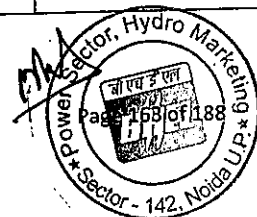


OPERATIONAL TEST:

No.	Particulars	Operational test	Remarks
TURBINE:			
1.	Movable Guide Vane	◆	Stroke check to be done
2.	Guide Vane operating mechanism	◆	--do--
3.	Instruments	◆	
SPHERICAL / BUTTERFLY VALVE:			
1.	Servomotor	◆	Stroke check to be done
2.	Other valves	◆	for hydraulic and electrical operations as applicable
GOVERNING SYSTEM:			
1.	Governor Electronic regulator	◆	
2.	Actuator/Pilot Servo Assembly	◆	To be tested with a testing regulator and testing servomotor
3. a)	Oil Pressure Unit	◆	i) Characteristic tests
b)	Non-return valves	◆	i) Relationship between delivery pressure and delivered quantity ii) Voltage, current and efficiency



Section-29: VPHEP-EM Works-QAI Requirement



c)	Safety valves	◆	Safety valve operation i) Characteristics ii) Operational checks
4.	Instruments	◆	
5.	Speed relays	◆	
6.	Oil pump	◆	Pump capacity

COOLING WATER SYSTEM / DRAINAGE- DEWATERING SYSTEM / COMPRESSED AIR SYSTEM:			
1.	Pumps	◆	Pump capacity and head
2.	Compressors	◆	Compressors capacity and pressure
3.	Strainer	◆	Pressure loss across strainer

NOTES/ ABBREVIATIONS (Appendix :III):

- Tests/ inspections by manufacturer's inspector at his or vendor's works. Test Certificates to be submitted to Purchaser.

◆ Test by manufacturer's inspector and witness by Purchaser's Inspector/ consultants.

RT = Radiographic Test

UT = Ultrasonic Test

MT = Magnetic Particle Test

DPT = Dye Penetration Test

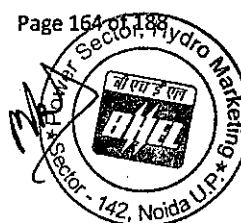
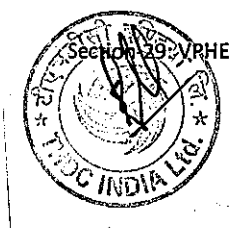
SR = Stress Relieving

HV = High Voltage

Y = Yes

N = No

Note: Above is an indicative list of Tests. The supplier shall have to submit a detailed list of Tests.



AC SYSTEM

1.00.00 CHILLING UNIT

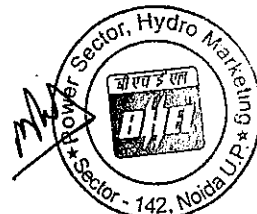
- 1.01.00 Refrigerant Compressor (Reciprocating/ Screw/ Centrifugal)**
- 1.01.01 Hydraulic/Pneumatic test of castings for cylinder block/crank case/casings shall be carried out. No leakage shall be permitted.
- 1.01.02 DPT of connecting rod, piston, crankshaft, screw, impeller, shaft, vanes, crank case/cylinder/casing etc. after machining shall be carried out.
- 1.01.03 All rotating parts of reciprocating, screw and centrifugal compressor shall be dynamically balanced to ISO 1940 Gr. 6.3
- 1.01.04 Leak tightness & vacuum check for chilling units / compressor in assembled condition shall be carried out. No leakage shall be permitted.
- 1.01.05 Performance test of assembled compressor shall be done to check for following:
- (i) Capacity test for oil pump for reciprocating compressor.
 - (ii) No load air run (free run) test of all types of compressor to check FAD (Free air delivery), Noise, Vibration & Temp. rise of bearing & body.
 - (iii) Pump up & leak back rate for reciprocating compressor.
 - (iv) Functional run test and Capacity control check (for part load performance) shall be carried out.

2.00.00 CONDENSER & EVAPORATOR

- 2.01.00 DPT shall be carried out on welds.
- 2.02.00 10% RT of butt weld joint on shell shall be carried out.
- 2.03.00 Dimensional check including tube hole dia, ligament, pitch etc. shall be carried out.
- 2.04.00 Mock-up test of tubes to tube sheet expansion shall be carried out. In case such test is already carried out for similar tube/tube sheet thickness and materials, records for the same shall be furnished for THDC review.
- 2.05.00 Hydraulic/Pneumatic test of Shell Side and Tube Side of condenser and evaporator as applicable shall be carried out. 'No leakage' shall be permitted.



Section-29: VPHEP-EM Works-QAI Requirement



Page 171 of 188

4.00.00 AIR HANDLING UNIT

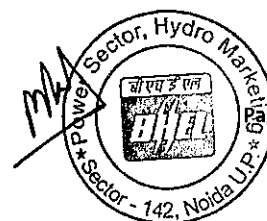
- 4.01.00 20% DPT of welding on fan casing, impeller, hub, blades, hub as applicable shall be carried out.
- 4.02.00 UT on fan shafts (dia equal to or above 50mm) shall be carried out. DP of fan shaft after machining shall be carried out
- 4.03.00 Blower fan shall be dynamically balanced to ISO 1940 Gr. 6.3
- 4.04.00 One fan of each type and size shall be performance tested as per AMCA / BIS for Air flow, Static Pressure, Speed, Efficiency, Power Consumption, Noise and Vibration.
- 4.05.00 One per type of assembled AHU (AHU casing and fan assembly) shall be subjected to free run test. Noise, Vibration and Temp. Rise of bearing shall be measured during run test.
- 4.06.00 All cooling coil shall be pneumatically tested and no leakage shall be permitted.

5.00.00 CENTRIFUGAL PUMP

- 5.01.00 UT on pump shaft (dia equal to or above 50 mm) and MPI/DPT on pump shaft and impeller after machining shall be carried out.
- 5.02.00 All rotating components of the pumps shall be dynamically balanced to ISO-1940 Gr. 6.3
- 5.03.00 A standard hydrostatic test shall be conducted on the pump casing with water at 1.5 times the shut off pressure on the head characteristics curve or twice the rated pressure whichever is higher, for a minimum duration of 30 minutes.
- 5.04.00 Standard Running Test
- 5.04.01 All pumps shall be tested in the manufacturer's works preferably with contract motor for capacity, efficiency, head and brake horsepower. Pump shall be given running test over the entire operating range covering from the shut-off head to the maximum flow. The duration of test shall be minimum one (1) hr. A minimum of five readings approximately equidistant shall be taken for plotting the curves with one point at design flow. Testing of pumps shall be in accordance with stipulations of Hydraulic Institute Standard (HIS) and/or as per applicable Indian Standard or equivalent. Acceptance norms shall be as per approved datasheet & HIS standard only.
- 5.04.02 Noise and vibration shall be measured at shop for reference purpose only.
- 5.04.03 Pumps shall be subjected to strip down examination visually to check for mechanical damages after testing at shop in case abnormal noise level and/or excessive vibration are observed during the shop test.
- 5.04.04 NPSH test shall be conducted with water as the medium, if required as per approved data sheets.



Section-29 VPHEP-EM Works-QAI Requirement



Page 173 of 188

6.00.00 COOLING TOWER

- 6.01.00 UT of fan shaft and drive shaft (dia equal to or above 50mm) shall be carried out.
- 6.02.00 DPT of fan hub and shafts shall be carried out after machining.
- 6.03.00 Colour of fills shall be as per approved data sheet.
- 6.04.00 Fan assembly shall be statically balanced.
- 6.05.00 Cooling Towers being supplied to site in assembled condition shall be subjected to run test at shop to measure FAD, Noise & Vibration. For Cooling Towers being supplied in knocked-down condition, these tests shall be done at site

7.00.00 FANS:

- 7.01.00 20% DPT of welding on fan hub, blades, casing and impeller as applicable shall be carried out.
- 7.02.00 DPT of fan shafts shall be carried out after machining.
- 7.03.00 UT of fan shafts (dia equal to or above 50mm) shall be carried out.
- 7.04.00 Rotating components of all fans shall be dynamically balanced to ISO-1940 Gr. 6.3
- 7.05.00 All Centrifugal Fans shall be subjected to run test for 4 hrs. or till temperature stabilization is reached. Vibration, Noise level, Temp. rise and current drawn shall be measured during the run test.
- 7.06.00 One fan of each type and size will be performance tested as per corresponding BIS code for Air flow, Static Pressure, Speed, Efficiency, Power Consumption, Noise, Vibration and Temp. Rise.

8.00.00 LOW PRESSURE AIR DISTRIBUTION SYSTEM

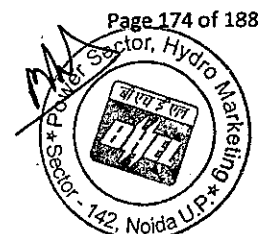
- 8.01.00 Functional tests for fire damper along with solenoid shall be done.
- 8.02.00 Prototype tests report of fire damper (duly approved/accepted by ENGG) for each type and size as per UL-555 for fire rating shall be furnished.
- 8.03.00 Site Test- After completion, all ducting system shall be checked/tested for air leakages/tightness (smoke test) at site.

9.00.00 INSULATION :

- 9.01.00 Insulation material shall be tested for all mandatory tests only as per relevant code/standard.
- 9.02.00 Thermal conductivity tests (for thermal insulation only) shall be done once in six months for insulation material manufactured during six months period for the same density and thickness of material as applicable as per IS: 3346 or equivalent standard.



Section-29: VPHEP-EM Works-QAI Requirement



10.00.00 AIR FILTERS:

10.01.00 Pre/Fine filters shall be tested for initial and final pressure drop Vs flow and average synthetic dust weight arrestance as per the requirement of BS 6540/ASHARE-52-76/EN779. HEPA (Absolute) filters shall be tested as per applicable code.

11.00.00 PIPES & FITTINGS:

11.01.00 All pipes and fittings shall be tested as per applicable codes / standard.

11.02.00 Site test- Pipes shall be tested at site hydraulically/pneumatically as per application requirement

12.00.00 VALVES & SPECIALTIES

12.01.00 Visual and dimensional check of valves as per relevant codes and approved drawing.

12.02.00 All the water line valves shall be hydraulically tested for body, seat and back seat (wherever provided) as per the relevant standard to which these valves are supplied irrespective of the working pressure for which these valves are selected. Check valves shall also be tested for leak tightness test at 25% of the specified seat test pressure.

12.03.00 Refrigerant line valves shall be pneumatically tested for body and seat leakage test.

12.04.00 Valves shall be offered for hydro test and pneumatic test in unpainted condition.

12.05.00 Functional check of the valves for smooth opening and closing shall be done.

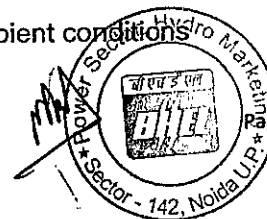
12.06.00 Performance test to check pressure drop Vs flow shall be carried out for one valve of each type, size and rating for 'Balancing Valve'/Globe Valves with orifice.

12.07.00 Packaged Air Conditioners (PAC)

12.07.01 Compressor of packaged air conditioner shall be tested as per relevant codes

12.07.02 PAC shall be subjected to production routine test in accordance with IS: 8148 for the following.

- a) General Running Test
- b) Pressure/Leakage test
- c) Insulation Resistance test
- d) High Voltage test
- e) Performance test on one PAC at ambient conditions



VENTILATION SYSTEM

1.00.00 FANS:

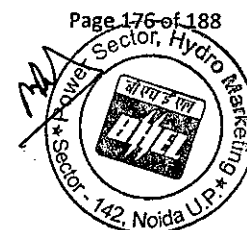
- 1.01.00 20% DPT of welding on fan hub, blades, casing and impeller as applicable shall be carried out.
- 1.02.00 DPT of fan shafts shall be carried out after machining.
- 1.03.00 UT of fan shafts (dia equal to or above 50mm) shall be carried out.
- 1.04.00 Rotating components of all fans shall be dynamically balanced to ISO-1940 Gr. 6.3
- 1.05.00 All Centrifugal Fans shall be subjected to run test for 4 hrs. or till temperature stabilization is reached. Vibration, Noise level, Temp. rise and current drawn shall be measured during the run test.
- 1.06.00 One fan of each type and size will be performance tested as per corresponding BIS code for Air flow, Static Pressure, Speed, Efficiency, Power Consumption, Noise, Vibration and Temp. Rise.

2.00.00 CENTRIFUGAL PUMP

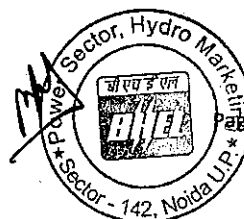
- 2.01.00 UT on pump shaft (dia. equal to or above 50 mm) and MPI/DPT on pump shaft and impeller after machining shall be carried out.
- 2.02.00 All rotating components of the pumps shall be dynamically balanced to ISO-1940 Gr. 6.3
- 2.03.00 A standard hydrostatic test shall be conducted on the pump casing with water at 1.5 times the shut off pressure on the head characteristics curve or twice the rated pressure whichever is higher, for a minimum duration of 30 minutes.
- 2.04.00 Standard Running Test
 - 2.04.01 All pumps shall be tested in the manufacturer's works preferably with contract motor for capacity, efficiency, head and brake horsepower. Pump shall be given running test over the entire operating range covering from the shut-off head to the maximum flow. The duration of test shall be minimum one (1) hr. A minimum of five readings approximately equidistant shall be taken for plotting the curves with one point at design flow. Testing of pumps shall be in accordance with stipulations of Hydraulic Institute Standard (HIS) and/or as per applicable Indian Standard or equivalent. Acceptance norms shall be as per approved datasheet & HIS standard only.
 - 2.04.02 Noise and vibration shall be measured at shop for reference purpose only.
 - 2.04.03 Pumps shall be subjected to strip down examination visually to check for mechanical damages after testing at shop in case abnormal noise level and/or excessive vibration are observed during the shop test.
 - 2.04.04 NPSH test shall be conducted with water as the medium, if required as per approved data sheets.



VPHEP-EM Works-QAI Requirement



- 3.00.00 LOW PRESSURE AIR DISTRIBUTION SYSTEM**
- 3.01.00 Functional test for fire damper along with solenoid shall be done.
- 3.02.00 Prototype tests report of fire damper (duly approved/accepted by Engineering) for each type and size as per UL-555 for fire rating shall be furnished.
- 3.03.00 Site Test- After completion, all ducting system shall be checked/ tested for air leakages/tightness (smoke test) at site.
- 4.00.00 INSULATION:**
- 4.01.00 Insulation material shall be tested for all mandatory tests only as per relevant code/standard.
- 4.02.00 Thermal conductivity tests (for thermal insulation only) shall be done once in six months for insulation material manufactured during six months period for the same density and thickness of material as applicable as per IS: 3346 or equivalent standard.
- 5.00.00 AIR FILTERS:**
- 5.01.00 Pre/Fine filters shall be tested for initial and final pressure drop Vs flow and average synthetic dust weight arrestance as per the requirement of BS 6540/ASHARE-52-76/EN779. HEPA (Absolute) filters shall be tested as per applicable code.
- 6.00.00 PIPES & FITTINGS:**
- 6.01.00 All pipes and fittings shall be tested as per applicable codes / standard.
- 6.02.00 Site test- Pipes shall be tested at site hydraulically/pneumatically as per application requirement.
- 7.00.00 VALVES & SPECIALTIES**
- 7.01.00 Visual and dimensional check of valves as per relevant codes and approved drawing.
- 7.02.00 All the water line valves shall be hydraulically tested for body, seat and back seat (wherever provided) as per the relevant standard to which these valves are supplied irrespective of the working pressure for which these valves are selected. Check valves shall also be tested for leak tightness test at 25% of the specified seat test pressure.
- 7.03.00 Valves shall be offered for hydro test and pneumatic test in unpainted condition.
- 7.04.00 Functional check of the valves for smooth opening and closing shall be done.
- 7.05.00 AIR WASHER AND UAF (UNITARY AIR FILTRATION) SYSTEM**
- 7.06.00 Random 10% DPT on welds
- 7.06.01 Hydraulic test of pressure parts at 1.5 times the design. Pressure and water fill test of tanks shall be carried out.
- 7.06.02 Trial assembly of Air washer/UAF for one of each size shall be done in shop.



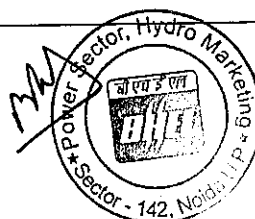
CLAUSE NO.	QUALITY ASSURANCE AND TESTING	
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CENTRIFUGAL PUMPS: Piping, Valves & Fitting and Painting

1.00.00	CENTRIFUGAL PUMPS (HORIZONTAL / VERTICAL / VERTICAL TURBINE PUMPS / SUBMERSIBLE PUMPS)
	The manufacturer shall conduct all tests required to ensure that the equipment furnished shall conform to the requirements of this specification and in compliance with the requirement of applicable Codes and Standards. The particulars of the proposed tests shall be submitted to the Owner for approval before conducting the tests.
1.01.00	Hydrostatic Tests
	A Standard Hydrostatic test shall be conducted on the pump casing with water at 1.5 times the shut-off pressure on the head characteristic curve or twice the rated pressure, whichever is higher. While arriving to the above pressure, the maximum suction head specified in Data Sheet shall be taken into account. The hydrostatic tests on the casing shall be conducted for a minimum duration of 30 minutes.
1.02.00	Performance Tests
	a. All the pumps shall be performance tested at the Manufacturer's Works over for entire operating range covering from the shut off head to the maximum flow. The duration of test shall be minimum one (1) hour. A minimum of seven readings approximately equidistant shall be taken for plotting the curves with one point at rated - flow. Testing of pumps shall be in accordance with stipulations of Hydraulic Institute Standards, USA or as per applicable equivalent Codes/Standards. b. The performance tests shall be tested at rated speed only. c. The pumps for which LD on power consumption is applicable, - shall be tested with the actual drive motor being furnished. For other pumps the test may be conducted with calibrated shop motor. d. Pumps shall be subjected to strip down examination visually to check for mechanical damages after performance testing at shop.
1.03.00	For Vertical Turbine Pumps
1.03.01	After the manufacture, the pumps shall be subjected for a prototype performance test at the manufacturer's works to determine the power consumption and the head capacity characteristic in the presence of Owner's representative as per requirements of BS:5316, HIS, USA or equivalent. Performance test at design duty point shall be done keeping minimum submergence of the pump identical to that specified for the site conditions. Bidder shall submit the test procedure for Owner's approval after award in case such test facilities are not available at manufacturer's works the test may be carried out at any other test facility with the approval of the Owner. All costs associated with testing at Contractor's works or at any other test facility shall be included in contract price.
1.03.02	Contractor shall submit along with his offer details to the proposed test facilities available for testing the pumps. The details must include the capacity, head, maximum motor rating, voltage level sanctioned load and permissible starting current.
1.03.03	No negative tolerance shall be permitted on head (H), capacity (Q) and the pump efficiency (n) during shop tests. Accuracy of instruments used shall be +1.5% or better for measurement of flow and +0.5% or better for measurement of pressure and power.



Section-29: VPHEP-EM Works-QAI Requirement

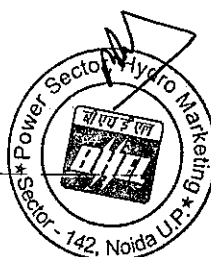


Page 181 of 188

CLAUSE NO.	QUALITY ASSURANCE AND TESTING	
1.04.00	Noise and Vibration Levels	
	Noise and vibration shall be measured during the performance testing at shop as well as during the site test. Noise level measurement will be made as per applicable internationally acceptable standard. The measurement shall be carried out all round the pump and motor set at a distance of one meter from the nearest surface of the machine at a height of 1.5m from the floor level. A minimum of six (6) points should be covered for measurement. The tests shall be carried out with the machine operating at rated speed and as near as possible to the rated power. Corrections for background noise and correction on account of test environment will be considered in line with applicable standard. For this purpose all the additional data required should be collected during the test. Vibration level check will be done as per Hydraulic Institute Standards. Vibration would be checked at thrust bearing location in horizontal, radial and vertical directions. Acceptable limits would be as per Hydraulic Institute Standards.	
1.05.00	Mechanical Balancing	
1.05.01	Rotating components of the pumps shall be subjected to dynamic balancing tests as per ISO-1940, Gr.6.3 or better.	
1.06.00	Visual Inspection	
1.06.01	Pumps shall be offered for visual inspection to the Owner before shipment. The components of the pumps shall not be painted before inspection.	
1.07.00	Material Test Certificate	
	Materials of the various pump components shall be tested in accordance with the relevant standards. Test Certificates for these shall be furnished for the Owner's approval. Where stage inspection is specified, all material test certificates shall be correlated and verified with the actual material used for construction before starting fabrication by Owner's inspector who shall stamp the material. In case mill test certificates for the material are not available, the supplier shall carry out physical and chemical tests at his own cost from a testing agency, as per the requirement of specified material standard.	
1.08.00	Non-Destructive Testing	
	Non-destructive testing of the pump components shall be conducted in accordance with relevant standards and as specified in Table.	



Section 9: VHEP-EM Works-QAI Requirement

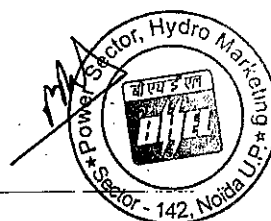


Page 182 of 188

CLAUSE NO.	QUALITY ASSURANCE AND TESTING
2.00.00	PIPING, VALVES AND FITTINGS
2.01.00	Piping & Fittings
	All the mechanical and chemical tests including optional tests if any as per the relevant standards shall be carried out and the test certificates for the same shall be submitted for owners approval. The minimum hydraulic testing criteria for all the pipes before and after the rubber lining (if provided) shall be at two times, the operating pressure or 1.5 times the maximum attainable pressure for a period of 30 minutes, whichever is greater. However, If the Standard of supplied piping specifies more stringer requirements than the above criteria, then the hydraulic tests shall be conducted as per the piping standard. For rolled and welded pipes quality requirements refer sub section III-E01 "Cooling towers –Mechanical" "All pipes and fittings shall be visually and dimensionally examined as per applicable standards."
	All rubber lining is to be subjected to the following tests as per IS:4682 part I (a) Adhesion test (b) Tests to check resistance to bleeding (c) Measurement of thickness of lining (d) Shore hardness test (e) Spark test at High voltage 5 KV/mm of thickness Welding procedure and welder performance qualifications shall be carried out.
2.02.00	Valves/Gates/Strainers
	Rubber lining on valves Gates/Strainers shall be checked in accordance with IS:4682 Part I for the following tests :
	(a) Adhesion test (b) Tests to check resistance to bleeding (c) Measurement of lining thickness (d) Shore hardness test (e) Spark test at high voltage at 5 KV/mm of thickness.
	Gates shall be tested against leakage and strength as required in the standard. Strainer shall be hydraulically tested its strength and the pressure drop across the strainer assembly shall be verified at design flow for clean condition.
3.00.00	PAINTING
	All painted surfaces shall be visually checked for uniformity. The dry film thickness of coating of paint shall be measured.



Section-29: VPHEP-EM Works-QAI Requirement



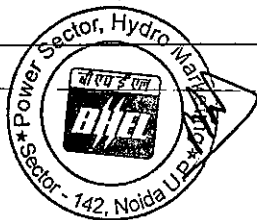
Page 183 of 188

COOLING WATER SYSTEM

Pg. 1 of 4

Tests/ Check	Items / Components	Material Test	WPS/PQR/Welder Qualification	DPT/MPI	Ultrasonic test	RT	Balancing	Hydraulic / Water Fill test	Pneumatic Test	Assembly/ fit up	Dimensions	Functional/Operational Test	Performance Test	Other Test	All Test as per relevant Standard/ Approved Data Sheets	Remarks
A. PUMPS *													Y ²			
1	Shaft	Y ^a		Y ^b	Y ^c					Y ¹	Y					
2	Impeller	Y ^a		Y ^b		Y ³	Y									
3	Suction Bell / Bowl Castings/ Inserts	Y ^a		Y ^b				Y			Y			Y ^b		
4	Discharge Head / Column Pipes / Distance Piece	Y ^a	Y	Y ^b		Y ⁴		Y		Y				Y ^b		
B. BUTTERFLY VALVES								Y ¹		Y	Y	Y		Y ^a	Y	
1	Body & Disc	Y ^a		Y ^b										Y ^a		
2	Shaft	Y ^a		Y ^b	Y ^c									Y ^a		
3	EH Actuators	Y ^a		Y				Y	Y	Y		Y				
C. RE JOINTS		Y ^a						Y ¹⁰		Y	Y			Y ¹¹		
D. STOP LOG GATES		Y ^a		Y ^b						Y	Y			Y ¹²		
E. R & W PIPES		Y ^a														
F. CRANES & HOISTS		Y ^a		Y ^b	Y ^c	Y ¹⁴				Y	Y	Y		Y ¹⁵	Y ¹⁶	
REFER NOTE 13																

Remarks: See following NOTES.



COOLING WATER SYSTEM

Pg. 2 of 4

Tests/Check		Material Test	WPS/PQR/Welder Qualification	DPT/MPI	Ultrasonic test	RT	Balancing	Hydraulic / Water Fill test	Pneumatic Test	Assembly/ fit up	Dimensions	Functional/operational Test	Performance Test	Other Test	All Test as per relevant Standard/ Approved Data Sheets	Remarks
Items / Components																
G.	VENTILATION FANS															
1	Hub/Blades/Casing /Impeller	Y		Y			Y				Y		Y			
2	Shaft	Y ^a		Y	Y ^c											
3	Pre/Fine Filters	.												Y ¹¹		

* PUMPS mean Pumps in primary and secondary circuits

Remarks: See following NOTES.

Pg. 2 of 4



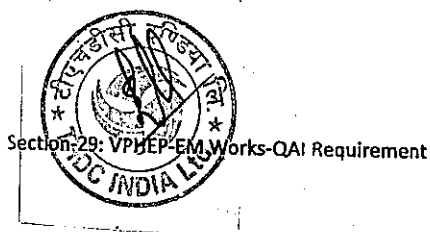
Section-29: VPHEP-EM Works-QAI Requirement

Page 185 of 188

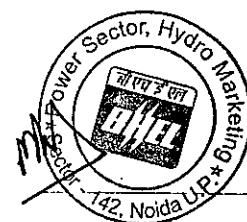
COOLING WATER SYSTEM :**NOTES**

Pg. 3 of 4

a	One per Heat/ Heat Treatment Batch/ Lot.
b	On machined surfaces only for Castings / Forgings and on Welds of Fabricated Components. 100% DP test on butt weld joints of Girder, End Carriage, Crab (in tension, compression) and in butt weld joint of rope drum
c	For Shaft diameter. ≥ 40 mm and for forged part / plate thickness ≥ 40 mm (in case of EOT crane components)
1	Trial assembly of all Vertical Turbine Pump components with Column Pipes, Discharge Head, and Motor Stool shall be carried at shop.
2	Performance testing of Pumps shall be carried out at shop, as per HIS standard to determine Head & Flow Characteristics.
3	Radiographic Examination shall be conducted as per ASTM E186/E446 with Severity Level 2 for Gas porosity, Level 3 for Sand, Slag and Shrinkage. Cracks, Inserts and Mottling are not acceptable. Radiographic Examination should cover Vanes, Vane Junctions, Full Radial depth of Hub & other accessible areas of the rest of the Impeller.
4	Spot Radiography for Butt weld of Fabricated Components for thickness of 10mm & above shall be carried out.
5	Segmental Flanges exceeding 37.5 mm thickness shall be stress relieved after welding. All butt weld joints in segmental flange shall be examined by Radiographic Test. (RT may be replaced by Ultrasonic Test due to constraint if any.) Maximum number of segments shall be 4 only.
6	No repair welding is permitted on Cast Iron / Alloy Cast Iron Castings.
7	Hydraulic Test of Body, Seat and Disc strength shall be carried out in accordance with latest edition of AWWA C-504. Actuator operated Valves shall be checked for Seat Leakage by closing the Valve with Job Actuator. Seat Leakage test shall be carried out in both directions.
8	Proof of Design Test shall be carried out in presence of Owner's representative, if not carried out earlier under Third Party Inspection, in line with AWWA C-504 requirements. In case of Valves > 72" size, number of Cycles shall be 1000, for each Size & Class of Valve offered. Valve subjected to POD Test shall not be supplied to Owner.
9	For Butterfly Valves of Fabricated construction (Sizes 600mm and above) Butt Welds of thickness 20mm & above shall be subjected to 100% Radiography and Component shall undergo stress relieving.



Page 186 of 188



10	During Hydraulic & Vacuum test at 25mm Hg absolute in 3 different positions, the change in Circumference of the Arch should not be more than 1.5%. Permanent Set, after 24 hours of the test, should not exceed 0.5% of Arch.	
11	Tests on Rubber for Tensile, Elongation, Hardness, Hydraulic Stability as per ASTM D-471, Ozone Resistance test as per ASTM D-1149, Aging test, Fabric Strength of Synthetic Fiber, Adhesion strength of Rubber to Fabric and Rubber to Metal shall be carried out.	
12	Smooth operation and Leakage test shall be carried out at site.	
13	Followings are the testing requirements for fabrication of pipes at site / manufacturing works	
	Tests	Quantum of Check
	WPS, PQR, Welder Qualification Test	100%
	DPT on root run	100% for pipes up to 1200 mm diameter
	DPT after back gauging	100% for pipes above 1200 mm diameter
	RT	5%
	DPT on finished butt weld joints	10%
	Hydraulic Test	1.5 times the design pressure or 2 times the working pressure which ever is higher.
	Note:- Butt weld joints which can not be hydraulic (pressure) tested; shall be examined 100% by Radiographic Test (RT)	
14	100% RT shall be carried out on Butt – weld joints in tension and in Butt Weld Joints of rope drum. 10% RT shall be carried out on Butt – weld joints in compression.	
15	Reduction gears shall be tested for reduction ratio, backlash and contact pattern. Gear box shall be subjected to no – load test to check for oil leakage, temperature rise, noise and vibration.	
16	Full Load and Overload test shall be carried out at shop as per the governing standard. All motions including performance of Electro-Mechanical Brakes if any shall also be checked.	
17	Type / Routine tests as per requirements of BS-6540/ ASHRAE-52-76 for Dust arrestance shall be carried out.	

Pg. 4 of 4



Section-29: VPHEP-EM Works-QAI Requirement



Page 187 of 188

EQUIPMENT COOLING WATER SYSTEM													
TEST / CHECKS		Material Test	WPS/PQR/Welder Qualification	DPT/MPI	Assembly Fit Up	Visual & Dimensional Check	UT	RT	Hydraulic / Water Fill	Balancing	Type Test	Performance Test	Other Test
ITEM / COMPONENTS													
A	PLATE TYPE HEAT EXCHANGER		Y	Y ³	Y	Y			Y				
A.1	Heat Transfer Plates	Y ¹		Y ²		Y	Y ^{5a}						Y ⁷
A.2	Gaskets	Y				Y							
A.3	Cover Plates (Front & Rear)	Y ¹				Y	Y ^{5a}						
A.4	Tie Rods	Y ¹		Y ⁴			Y ⁶						
NOTES													
1 One per heat / HT batch													
2 DP Test shall be conducted for 10% of the lot of HT plates. However, in case of any defect, entire lot shall be tested and only defect free plates shall be accepted.													
3 100% DP Test shall be conducted on butt welds and 10% DPT on fillet weld after final run.													
4 100% DPT shall be carried out on machined surfaces.													
5 UT shall be done on plates with thickness 25 mm or above.													
6 UT shall be done on shaft / tie rod with diameter 50 mm or above.													
7 Each Plate after pressing shall be subject to either of the following tests, as per Manufacturer Practice													
a) ⁷ Light Box Test b) Vacuum Test c) Air Chamber Test													



Section 29: VPHEP-EM Works-QAI Requirement

Page 188 of 188



**ELECTRICAL EQUIPMENT SPECIFICATION
FOR
HVAC**

4 x 111 MW THDCIL VISHNUGAD HEP

SPECIFICATION NO.

VOLUME NO. : **II-B**

SECTION : **C**

REV NO. : **00** DATE : 02.01.2020

SHEET : 1 OF 3

**TECHNICAL SPECIFICATION
FOR
HVAC
(ELECTRICAL PORTION)**

ELECTRICAL EQUIPMENT SPECIFICATION FOR HVAC 4 x 111 MW THDCIL VISHNUGAD HEP	SPECIFICATION NO.
	VOLUME NO. : II-B
	SECTION : C
	REV NO. : 00 DATE : 02.01.2020
	SHEET : 2 OF 3

1.0 EQUIPMENT & SERVICES TO BE PROVIDED BY BIDDER:

- a) Services and equipment as per “Electrical Scope between BHEL and Vendor”.
- b) Any item/work either supply of equipment or erection material which have not been specifically mentioned but are necessary to complete the work for trouble free and efficient operation of the plant shall be deemed to be included within the scope of this specification. The same shall be provided by the bidder without any extra charge.
- c) Supply of mandatory spares as specified in the specifications.
- d) Erection and Commissioning spares.
- e) Erection & Maintenance tools & tackles.
- f) Electrical load requirement for HVAC.
- g) All equipment shall be suitable for the power supply fault levels and other climatic conditions mentioned in the enclosed project information.
- h) Bidder to furnish list of makes for each equipment at contract stage, which shall be subject to customer /BHEL approval without any commercial and delivery implications to BHEL.
- i) Various drawings, data sheets as per required format, Quality plans, calculations, test reports, test certificates, operation and maintenance manuals etc shall be furnished as specified at contract stage. All documents shall be subject to customer/BHEL approval without any commercial implication to BHEL.
- j) Motor shall meet minimum requirement of motor specification.
- k) LT switchgear panels shall meet minimum requirement of LT switchgear specification.
- l) LT power & control cables shall meet minimum requirement of LT power & control cables specification.
- m) Cabling, earthing & lightning protection shall meet minimum requirement of cabling, earthing & lightning protection specification.
- n) All power cables to HVAC MCC and from MCC to electric motors and control cables to the devices stipulated by this technical specification, as well as cables to the common control and annunciation panel envisaged in the computerised control room, cable trays, conduits, supports and all accessories for cables including laying of power and control cables on cable trays and their termination on MCC and panels are covered in the scope of supplies of this technical specifications.
- o) The scope of supply shall include special tools and tackles, spare parts, all relevant drawings, data and instruction manuals.

2.0 EQUIPMENT & SERVICES TO BE PROVIDED BY PURCHASER FOR ELECTRICAL & TERMINAL POINTS:

Refer “Electrical Scope between BHEL and Vendor”.

3.0 DOCUMENTS TO BE SUBMITTED ALONG WITH BID

- 3.1 Bidder shall confirm total compliance to the electrical specification without any deviation from the technical/quality assurance requirements stipulated. In line with this two signed and stamped copies of the following shall be furnished by the bidder as technical offer:

	ELECTRICAL EQUIPMENT SPECIFICATION FOR HVAC 4 x 111 MW THDCIL VISHNUGAD HEP	SPECIFICATION NO. VOLUME NO. : II-B SECTION : C REV NO. : 00 DATE : 02.01.2020 SHEET : 3 OF 3
a) A copy of this sheet "Electrical equipment Specification for HVAC" and sheet "Electrical Scope between BHEL and Vendor" with bidder's signature and company stamp. b) List of Erection and Commissioning spares. c) List of Erection & Maintenance tools & tackles. d) Electrical load requirement 3.2 No technical submittal such as copies of data sheets, drawings, write-up, quality plans, type test certificates, technical literature, etc, is required during tender stage. Any such submission even if made, shall not be considered as part of offer. 4.0 List of enclosures : a) Electrical scope between BHEL & vendor. b) Technical specification, datasheets & quality plans for 415V Electric motors. c) Technical specification, datasheets & quality plans for 415V LT Switchgear. d) Technical Specification, datasheets & quality plans for LT power & control cables. e) Technical Specification, datasheets & quality plans for cabling, earthing & lightning protection. f) Electrical Load data format. 5.0 The stipulations of specification (in decreasing order) Section-C(customer specification), Datasheet-A, followed by those of Section-D, shall prevail in case of any conflict between the stipulations of specification Section-C (customer specification), Datasheet-A and Section-D.		

ANNEXURE – I TO SECTION – C : STANDARD ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR
PACKAGE: HVAC (CIVIL IN CUSTOMER-THDCIL SCOPE)

PROJECT:

S.NO	DETAILS	SCOPE SUPPLY	SCOPE E&C	REMARKS
1	415V MCC	Vendor	Vendor	1. 415 V AC/240 V AC supply shall be provided by Vendor *
2	Local Push Button Station (for motors)	Vendor	Vendor	Located near the motor.
3	Power cables, control cables and screened control cables for a) both end equipment in vendor's scope b) one end equipment in vendor's scope	Vendor Vendor	Vendor Vendor	1. Finalisation of cable sizes shall be done by Vendor meeting specification requirements. Vendor shall provide lugs & glands accordingly. 2. Laying of cables by Vendor. 3. Termination at equipment terminals by Vendor.
4	Any special type of cable like compensating, co-axial, prefab, MICC, fibre optical etc.	Vendor	Vendor	
5	Cable trays, accessories & cable trays supporting system	Vendor	Vendor	
6	Cable glands and lugs for equipments supplied by Vendor	Vendor	Vendor	1. Double compression Ni-Cr plated brass cable glands 2. Solder less crimping type heavy duty tinned copper lugs for power cables 3. Solder less crimping type heavy duty copper lugs for control cables.
7	Conduit and conduit accessories for cabling between equipments supplied by vendor	Vendor	Vendor	Conduits shall be medium duty, hot dip galvanised cold rolled mild steel rigid conduit as per IS: 9537. Makes of conduits shall be subject to customer approval at contract stage.
8	Lighting	BHEL	BHEL	
9	Equipment grounding & lightning protection	Vendor	Vendor	
10	LT Motors with base plate and foundation hardware	Vendor	Vendor	Makes shall be subject to customer approval at contract stage.
11	Mandatory spares	Vendor	-	Vendor to quote as per specification.
12	Recommended O & M spares, E & C spares, erection & maintenance tools & tackle.	Vendor	-	As per specification
13	Any other equipment/material/service required for completeness of system but not specified above (to ensure trouble free and efficient operation of the system).	Vendor	Vendor	
15	a) Input cable schedules (C & I) b) Cable interconnection details for above c) Cable block diagram	Vendor Vendor Vendor	- - -	Cable listing & cable routing for C & I systems for vendor supplied equipment shall be furnished during detail engineering by vendor in soft copies.

* (EXCEPT 4 nos. of feeders for (a) Fresh air fan of capacity 110000 CMH - 2 Nos of feeder (1-working, 1- standby) and (b) Centrifugal Exhaust Fan 200000 CMH - 2 Nos of feeder (1-working, 1- standby) shall be provided by BHEL. Cable & cabling for this load shall be in bidder scope.
BHEL shall provide two nos. of un-cabled Feeders of rating of 2000A for I/Cs of the HVAC MCC of bidder scope. All cable & cabling from BHEL MCC to bidder MCC is in the scope of bidder.

ANNEXURE – I TO SECTION – C : STANDARD ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR
PACKAGE: HVAC (CIVIL IN CUSTOMER-THDCIL SCOPE)

REV NO. : 00 DATE :
02.01.2020

S.NO	DETAILS	SCOPE SUPPLY	SCOPE E&C	REMARKS
16	Equipment layout drawings	Vendor	-	For ensuring cabling requirements are met, vendor shall furnish layout drawings (both in print form as well as in AUTOCAD) of the complete plant (including electrical area) indicating location and identification of all equipments requiring cabling, and shall incorporate cable trays routing details. Electrical equipment layout drawing shall be to BHEL approval.
17	Electrical Equipment GA drawing	Vendor	-	For necessary interface review.

NOTES:

1. Make of all electrical equipments/items supplied shall be reputed make & shall be subject to approval of BHEL/customer after award of contract.
2. All QPs shall be subject to approval of BHEL/customer after award of contract without any commercial implication.

SECTION – 10

TECHNICAL SPECIFICATIONS FOR AC & DC POWER CABLES, CONTROL & INSTRUMENTATION CABLES, CABLE RACKS, SUPPORTS, TRAYS & ACCESSORIES

10.1 SCOPE OF WORK

- 10.1.1 This section of specification covers complete design, engineering, manufacture, assembly, testing at works before dispatch, packing, forwarding, transportation, insurance, storage & preservation at project site, erection, testing & commissioning and remedial action, if any upto defects liability period of AC & DC Power & control cables, cable racks, trays, supports, cable lugs, glands and all other accessories as detailed hereinafter in this specification for Vishnugad Pipalkoti HEP. The scope of work also covers laying of power cables and other cables as detailed herein after in this specification on cable trays and in ground as required, their termination on various panels, marshalling boxes, equipment etc. in power house complex comprising underground machine hall and transformer hall caverns, various tunnels, pothead yard, BFV, GIS and GIB cavern, spherical Valve, Main Inlet (MIV) Chamber, service building at MAT portal, Control rooms at surge shaft, TRT outlet, Dam site & Desiltation chambers etc. The bidder shall also fabricate the support structures with sufficient free space of about 10% for cable racks & trays either at his works or at site and install them at various locations of the project as per approved drawings.
- 10.1.2 Civil works relating to cable facilities i.e. cable galleries /tunnel, cable trenches/ducts etc. are excluded from the scope of this specification. However, minor civil works like fixing of anchor bolts, breaking of wall/floor for putting conduits/pipes and sealing of wall/floor/shaft opening shall be within the scope of this specification.

- 10.1.3 The scope of work also includes erection, testing and commissioning of all the laid cables. Detailed engineering of the work involved is also covered in the scope of the Contract to the extent specified in these Technical Specifications.
- 10.1.4 All tests are to be carried out by the bidder in accordance with applicable standards. Any defect noticed during test or during the guarantee period is to be rectified by the bidder free of cost.
- 10.1.5 The bidder, when ordered in writing by the purchaser shall perform extra work not covered by the specifications or not included in the schedule, but forming an inseparable part of the contracted work.
- 10.1.6 In addition to the above, the bidders shall offer all other works incidental to and connected with the above services from delivery up to handing over of the equipment after successful commissioning.
- 10.1.7 The scope of the present Technical Specification shall also include supply, erection of cable racks, trays, conduits, supports and all other accessories for the power and control cables covered under these Technical Specifications and spread in the following areas:
- Underground power house caverns (M/c hall cavern and Tr. Hall cavern)
 - Various tunnels and access-adits
 - Service building near MAT portal.
 - Control rooms at Dam site, Desiltation chambers, pothead yard, BFV chambers, Surge shaft top & TRT outfall etc.
- 10.1.8 Cable supporting structures, trays and racks shall also have sufficient free space (about 10%) for laying a few cables supplied by others.

10.2.3 Control & Instrumentation cables (0.65/1.1 kV)

The control and instrumentation cables are required for interconnection between control panels of various systems of the VPHEP structures and for some systems as detailed herein after.

10.3 STANDARDS

All materials/equipment used in manufacturing the cables and associated accessories shall comply with applicable provisions of the latest editions of relevant International Standards, Bureau of Indian Standards, Indian Electricity Rules, Indian Electricity Act and other applicable statutory provisions in regulations. The cables and accessories stipulated in this specification shall conform to the latest applicable provisions of the following standards:

- | | | |
|-----|----------------------------|--|
| 1) | IS:1554
(Part-I&II) | PVC insulated (Heavy duty) electrical cables for working voltages up to and including 11000 V |
| 2) | IS:7098 | Cross-linked polyethylene insulated PVC sheathed cables for working voltages from 3.3 kV up to and including 33 kV |
| 3) | IS:3961 | Recommended current ratings for cables |
| 4) | IS:8130 | Conductors for insulated electric cables and flexible cords |
| 5) | IS:5831 | PVC insulation and sheath of electric cables |
| 6) | IS:1753 | Aluminium conductors for insulated cables |
| 7) | IS:2982 | Copper conductors for insulated cables and cords |
| 8) | IS:3975 | Mild steel wires, strips and tapes for armouring cables |
| 9) | NEMA WC-5 | Thermoplastic insulated wires & cables for transmission and distribution of electric energy |
| 10) | ASTMD-2863 | Method for measuring minimum oxygen concentration to support candle-like combustion of plastic |
| 11) | IEEE 383/ | Standard for type test of electric cables |
| 12) | SEVENSK
STD.
4241475 | Flammability tests for cables |
| 13) | ASTMS 2743 | Test method for density of smoke from the burning or decomposition of plastics |

- | | | |
|-----|-----------------------------|--|
| 14) | IEC-60183 | Guide to the selection of high voltage cables |
| 15) | IEC- 60227 | Polyvinyl chloride (PVC) insulated cables of rated voltages up to and including 450/750 V |
| 16) | IEC-60228 | Conductors of insulated cables |
| 17) | IEC-60229 | Tests of cable oversheaths which have a special protective function and are applied by extrusion |
| 18) | IEC-60230 | Impulse tests of cable and their accessories |
| 19) | IEC-60287 | Calculation of the continuous current rating of cables (at 100% load) |
| 20) | IEC-60331 | Fire resisting characteristics of electric cables |
| 21) | IEC-60332, Part-I, II & III | Tests on electric cables under fire conditions |
| 22) | IEC-60502 | Extruded solid dielectric insulated power cables for rated voltages from 1 kV up to 30 kV |
| 23) | IEC-60540 & 60540A | Test methods for insulation and sheaths of electric cables and cords (elastomeric and thermoplastic compounds) |
| 24) | IEC-60724 | Guide to the short-circuit temperature limits of electric cables with a rated voltage not exceeding 0.6/1 kV |
| 25) | IEC-60754 | Test on gases evolved during combustion of electric cables |
| 26) | IEC-60811 | Common test methods for insulating and sheathing materials of electric cables |
| 27) | IS: 60226 | Specification for structural steel |
| 28) | IS: 816 | Code of practice for use of metal arc welding for general construction in mild steel. |
| 29) | IS: 4759 | Hot dip zinc coating on structural steel and other allied products. |
| 30) | IS: 2629 | Recommended practice for hot dip galvanizing of iron/steel |
| 31) | IS: 1239 (Part-I) | Mild steel tubes and iron fittings |
| 32) | IS: 3480 | Specification for flexible steel conduits for electrical wiring |
| 33) | IS: 3043 | Code of practice for earthing |
| 34) | IS: 3837 | Specification of accessories for rigid steel conduit for electrical wiring. |
| 35) | IS: 1653 | Rigid steel conduits for electrical wiring. |
| 36) | IS: 2667 | Fittings for rigid steel conduits for electrical wiring. |
| 37) | IS:10810 | Testing of cables |
| 38) | IS : 1255 | Installation & Maintenance of cables |
| 39) | IS:5578 | Guide for marking of insulated conductors |
| 40) | IS:11353 | Guide for uniform system of marking & identification of Conductors |
| 41) | IS : 1893 | Earthquake resistant design |
| 42) | IS:2062 | Steel for general structural purposes |
| 43) | ANSI / IEEE-80 | Earthing of the equipment |

- 44) IS:5608 Specification for low frequency wires and cables with PVC insulation and PVC Sheath
- 45) IS:800 Code of practice for use of structural steel in general building construction

10.5 SERVICE CONDITONS FOR CABLES AND ACCESSORIES

- 10.5.1 The cables shall be heavy duty type and suitable for continuous operation under climatic conditions prevailing at the site - hot humid tropical climate.
- 10.5.2 The supporting structure shall be designed for operation in seismic zone-V (as defined in latest edition of IS: 1893- Criteria of

Earthquake Resistance Design of Structures) which is prone to severe earthquakes. The supporting structure shall be strong enough to resist total operating stresses resulting from the forces in normal operation and in abnormal condition (due to short circuit) with forces superimposed due to occurrence of earthquake. Dampers and or additional supporting structures may be provided with the equipment, if necessary to their operation in the seismic zone. A horizontal seismic coefficient $\alpha_h=0.1675$ and vertical seismic coefficient $\alpha_v=0.1$ shall be considered for calculations of seismic forces acting on the equipment during earthquakes.

- 10.5.3 The cables shall have a termite , vermin , rodent-proof covering. The outer sheath of these cables shall be fire/ flame-retardant, low smoke (FRLS) and heat shrinkable type. The inner insulation of these cables shall be heat resistant (HR) type.
- 10.5.4 All 11 kV AC power cables shall have multicore aluminum conductor & XLPE insulation and all AC/DC power cables of 415 V & 220V rating (having multi core/single core aluminum /copper conductors) shall have PVC type of insulation.
- 10.5.5 The cables for outdoor installation where mechanical damages are possible, should be of armoured type. The armouring should be applied for cables over the inner sheath. It can be of steel strips/tapes/ round wires and shall conform to IS: 3975.
- 10.5.6 The cables shall be capable of satisfactory operation under a power supply system comprising of frequency variation of $\pm 5\%$,voltage variation of $\pm 10\%$ and a combined frequency & voltage variation of 10% (absolute sum). These shall be of type and design with proven record of power station installation.
- 10.5.7 All control and instrumentation cables shall be multi core annealed high conductivity copper conductor stranded type, insulated with HR-PVC insulation, PVC Sheathed conforming to IS:1554 (Part I or II) . The outer sheath is of specially formulated PVC compound.

All control cables (except current transformer secondary circuits) shall have atleast 20 % spare cores.

Control cables shall be standardised as much as possible in order to supply only a few different type (e.g. 4, 5, 7, 10, 14, 19, 27)

Control, annunciation, voltage and current transformers secondary wiring shall be 650/1100 V grade, multi-conductor cables, Single conductor cables shall be used for short runs.

For the cables for pick-ups, for data transmission to CCS and elsewhere the flexible cables are necessary, the conductors shall be plain copper, stranded wire type with PVC core insulation.

The cables for analog signals transmission to computers of Computerised Control System shall be 600 V grade screened twisted pair solid multi-conductor of 0.8 millimetre diameter.

The cables for current and voltage transformers secondary wiring, temperature detectors, gauges, alarm circuits, data transmission to Computerised Control System etc. shall have braided screen of tinned Cu or steel wires.

10.6 CABLE CONSTRUCTION DETAILS

The cables shall be multi core/single core XLPE, HR-PVC and special type as specified. All types of cables covered under these technical specifications shall be Fire Retardant Low Smoke type (FRLS).

10.6.1 Conductor

The conductor shall be made from high conductivity annealed tinned copper/aluminium metals (as specified against each type of cable in these specifications & schedule of quantities) to form compact conductor having a resistance within the limits specified in IS:8130.

10.6.2 Conductor Shield / Screen

The conductor having a semi-conducting screen shall ensure perfectly smooth profile and avoid stress concentration. The conductor screen shall be extruded in the same operation as the

insulation. The semi-conducting polymer shall be cross-linked (for XLPE Cables).

10.6.3 Insulation

The insulation of the cables shall be extruded type and shall be designed and manufactured for the specified system voltage. The manufacturing process shall ensure that insulation is free from voids. The insulation shall withstand mechanical and thermal stresses under steady state and transient operating conditions. The extrusion method should give very smooth interface between semi-conducting screen and insulation. The insulation of the cable shall be of high standard quality.

10.6.4 Insulation Shield / Screen

In XLPE cables, to confine electrical field to the insulation a non-magnetic semi-conducting shield shall be put over the insulation. The insulation shield shall be extruded in the same operation as the conductor shield and the insulation by Triple extrusion process. The XLPE cable insulation shall be strippable. Metallic screening as given in this specification for the various control, power and special cables shall be provided.

10.6.5 Inner Sheath

Application of inner sheath is required in the armoured cables only. The sheath shall be suitable to withstand the site conditions and specified temperature conditions. It shall be of adequate thickness and applied by a continuous process to produce a sheath of consistent quality free from any defects. The sheath shall be extruded type.

10.6.6 Armouring

Hard drawn aluminium wire or single galvanised steel tape/ strip shall be used for armouring of single core or multi core cables respectively. The hard drawn aluminium wire for armour shall be H4 grade. The diameter of the aluminium hard drawn wire and thickness of steel tape/strip shall be as per relevant standard.

10.6.7 Outer Sheath

Extruded PE/PVC outer sheath as specified shall be applied over armouring /insulation screen with suitable additives to prevent attack by rodents and termites. Necessary carbon coatings shall be provided over PE insulation (if provided) to make conducting surface for testing purpose.

10.6.8 Fillers

The cable shall have suitable fillers laid up with the conductors, before the sheath is applied and the fillers shall be of substantially circular cross section. Fillers shall be suitable for operating with the temperature of the conductor and compatible with the insulation.

10.7 SIZES & LENGTHS OF CABLES

10.7.1 The number of cores and sizes of the cables required for various circuits shall be as specified in the “Schedule of Requirements”, clause 10.25.

10.7.2 The cables covered by these specifications shall be supplied in one length or in standard lengths as approved by the purchaser. Standard length of each type and size of cables shall be indicated in the offer.

10.8 CABLE IDENTIFICATION SCHEME

10.8.1 To facilitate easy identification of phases, a colour scheme of Red, Yellow and Blue for phases and Black for neutral shall be adopted for power cables. Multi-core control cables shall be colour coded for identification of cores as per IS:1554-1976.

10.8.2 Following colour scheme shall be adopted for power cables:

1 – core	Red, Yellow, Blue or Black
2 – core	Red and Black
3 – core	Red, Yellow and Blue
4 – core	Red, Yellow, Blue and Black
5 – core	Red, Yellow, Blue, Black and Green or Light Green

Where the number of cores exceeds 5, two adjacent cores (counting core and direction core) in each layer are coloured Blue and yellow and the remaining cores are Light grey.

Control cables with core identified by numbers can also be provided.

- 10.8.3 All the cables shall carry manufacturer data in a permanent, legible manner at an interval of at least 3 metre run. The manufacturer's data shall include the manufacturer's name, cable size, voltage & current rating, type of insulation together with any other information which the manufacturer considers appropriate. In addition "THDC-VPHEP" shall also be printed at every 3 metre run.

10.9 TESTS AND INSPECTION

10.9.1 General

- 10.9.1.1 The bidder shall submit a list of testing facilities available in the manufacturer's works at the time of submitting the offer.
- 10.9.1.2 Authorised representative(s) of purchaser shall have at all reasonable times access to the contractor's/sub-contractor's premises or works to inspect and examine the materials and workmanship of the equipment during its manufacture.
- 10.9.1.3 All the required tests as per standard/specifications shall be carried out on bidder's expenses. If any component of the equipment fails in the specified tests, the same shall be replaced/rectified and again offered for inspection and testing.

10.9.2 Type Tests & Reports

- 10.9.2.1 The bidder shall submit following type test reports not older than 5 years in respect of all sizes of the cables as per requirement of latest standard/specification along with the bid for examination. The tests should have been conducted by a recognised test centre like CPRI, other public sectors, Govt. Agencies, etc. which must be acceptable to the purchaser. If the type tests & optional tests are not found satisfactory, the purchaser may ask the supplier for re-

conducting any or all the type tests & optional tests in presence of purchaser's representative without any extra cost.

Requirements of tests for Power & Control cables (IS:1554):

- a) Tests on conductor:
 - i) Measurement of Conductor resistance
 - ii) Tensile test (for Aluminium conductors only)
 - iii) Wrapping test (for Aluminium conductors only)
 - iv) Annealing test (for Cu)

- b) Tests for insulation and sheath:
 - i) Ageing test in air / oven.
 - ii) Heat Shrinkage/ deformation test.
 - iii) Loss of mass test in air / oven.
 - iv) Heat shock test.
 - v) Thermal stability test.
 - vi) Measurement of Insulation resistance.
 - vii) High voltage test (cable immersed in water).
 - viii) High voltage test at room temperature
 - ix) Tensile strength and elongation at break of insulation and sheath

- c) Tests for armouring wires/strips:
 - i) Nominal thickness (for steel strip)
 - ii) Nominal Diameter (for round wire)

10.9.3 Routine Tests (at Manufacturer's Works)

10.9.3.1 Following routine tests shall be conducted by the manufacturer during the manufacturing of equipments and test reports alongwith

description of test results , methodology etc. shall be submitted for purchaser's approval.

- a) Annealing test (for Cu).
- b) Tensile test (for Al).
- c) Wrapping test (for Al).
- d) Measurement of conductor resistance
- e) Measurement of thickness of insulation and sheath
- f) Measurement of tensile strength and elongation at break of insulation and sheath.
- g) Insulation resistance measurement
- h) High voltage test at room temperature in air (Dielectric test).

10.9.3.2 Following Routine & Optional tests (as per standard) shall be conducted in presence of purchaser. Test reports shall be submitted by the firm and got approved by purchaser before despatch of equipment / material.

- a) Conductor resistance measurement (Routine Test)
- b) High voltage test at room temperature (Routine Test)
- c) Insulation resistance measurement (Routine Test)
- d) Cold bend test (Optional)
- e) Cold impact test (Optional)
- f) Armour resistance measurement (Optional)
- g) FRLS test (Optional)

(Under FRLS tests as per IEC-60332, following parameters as detailed below are to be determined in addition to the tests specified in IEC-60332:

- i) HCL gas evaluation test (IEC - 754.1).
- ii) Oxygen Index (ASTM-D-2863).

- iii) Temperature Index (ASTM-D-2863).
 - iv) Smoke density test (ASTM-D-2863).
 - v) Flammability test (IEC-332.1).
 - vi) Swedish Chimney test (SS-424 14 75).
- h) As per relevant standards and approved drawings, cable drums shall be inspected visually & dimensionally.
- i) XLPE cables shall be tested as per IS: 7098.
- j) Any other test specified by relevant IS as necessary for factory acceptance.

10.9.4 Testing & Commissioning at Site

- 10.9.4.1 The specified power cables shall be commissioned progressively in a phased manner to be decided through mutual consultation between the bidder and the purchaser at the time of the award of the Contract.
- 10.9.4.2 Bidder shall be fully responsible for correct terminations and if at the time of commissioning some modifications/rectifications are required the same shall be carried out by him free of cost.
- 10.9.4.3 If any terminations/cable boxes etc. fail at the time of commissioning, the bidder shall be responsible to replace the same free of cost.
- 10.9.4.4 While testing the cables, damage occurs to any equipment, cables etc. not covered under the scope of this package, due to negligence of the bidder or his representative, shall be sole responsibility of the bidder to replace the same free of cost.
- 10.9.4.5 The bidder shall carry out the following commissioning tests and checks. In addition, the bidder shall also carry out all other checks and tests which are recommended by the manufacturer.
 - i) Check for physical damage, if any
 - ii) IR test (each core to earth & core to core)
 - iii) Continuity test
 - iv) Dielectric tests
 - v) Identification of cores (before & after termination)

- 10.9.4.6 Test results of the commissioning tests conducted at site shall be submitted to the purchaser within 3 days for approval. After approval has been received, the cables shall be connected to the line terminals.

10.10 SUBMISSION OF DRAWINGS AND TECHNICAL LITERATURES

- 10.10.1 The bidder shall submit full technical details, descriptive literatures, leaflets and the general drawings of the cables showing details of conductors, insulation, sheaths etc. and technical particulars of cable racks, trays, supports etc. with the bid.

- 10.10.2 The bidder shall furnish following design drawings for the purchaser's approval after award of contract:

- i) General layout arrangement for different sizes of cables trays, racks, supports, conduits etc.
- ii) Different type of cable termination lugs, glands and jointing arrangement proposed.
- iii) Allocation of Power cables and control cables on different cable racks and trays.
- iv) Embedment details of plates, channels and fixing/assembly of cable racks / support system etc.

- 10.10.3 After the final approval of the above design drawings, all the approved drawings alongwith a set of reproducibles (soft copy in CD form) shall be submitted.

- 10.10.4 The bidder shall also supply detailed instructions & maintenance manuals for purchaser's references.

10.11 ERECTION OF CABLES, TRAYS, RACKS & SUPPORTS ETC.

10.11.1 General

- 10.11.1.1 The bidder shall furnish and install all necessary cable trays / racks and cable support systems complete with brackets, supports,

hardware and special fittings for power and control cables , cable trenches & ducts as specified herein or as approved by the purchaser. Special fittings shall include tees, wyes, bends, crosses, dividers, reducers, dropouts, connectors, supports and all other materials required to form a complete cable tray system. Supports shall allow future installation of additional trays, where required , without disturbing the existing installation.

The power & control cables shall run separately on cable racks/trays, in cables /cable tunnels and on columns, walls, ceiling and pulled through pipes

- 10.11.1.2 The bidder in his design shall give preference to the use of cable trays through out. Where this is not feasible because of space, cable supports may be used, subject to purchaser's approval.
- 10.11.1.3 The bidder shall supply and be responsible for carrying out proper fixing of the cables at regular intervals with non magnetic cable fixing strips (moulded fibre glass strip/PVC sleeved clamps), fasteners, etc., wherever necessary to hold the cables firmly to the trays.
- 10.11.1.4 Cushion type cable clamps shall be provided to hold firmly the cables on the steel supports without harming the cable insulation where laying of racks & trays is not feasible.
- 10.11.1.5 The bidder will submit typical drawings along with Tender giving proposed clamping arrangement and also give distance of clamping at bends and in regular run of cables.
- 10.11.1.6 Power cables in the power house and other areas shall be laid on the cable racks/ supports installed along the walls & roofs, in cable tunnels, trenches, ducts and shafts etc.
- 10.11.1.7 The bidder shall bring his own tools & plants such as welding set, cutting torches, crimping tools, wire cutters etc. for undertaking and completing the work. The purchaser shall not supply any material in this regard.

- 10.11.1.8 The bidder shall also be responsible for receiving & transporting the cables, material for cable racks, trays, supports and other accessories from the project store to the work site.

10.11.2 Cable installation

The following are some of the salient factors which shall be kept in view during installation of XLPE/PVC insulated cables:

- i) Before laying, the insulation of the cables shall be checked with megger as a preliminary check against any probable damage. A log book of such meggar value shall be maintained by the bidder.
- ii) The drum shall be rolled in the direction of arrow for rolling marked on the drum.
- iii) The joints being the weakest point of the electric power transmission system, therefore the prefabricated type of joints shall be preferred otherwise necessary precautions/ instructions of the Manufacturer for making joint at site shall be strictly followed.
- iv) Minimum bending radius i.e. 12 times of the overall diameter of the cable shall be maintained.

10.11.3 Cable Termination

- 10.11.3.1 All cables that will be laid by the bidder shall be terminated at both ends. The bidder shall make all electrical connections strictly in accordance with the purchaser's cable schedule (prepared after detailed engineering showing allocation of cable routes made by the bidder) and shall provide numbered ferrules at each connecting terminal in order to check connections without any difficulty. One termination shall mean connecting both ends of one core of a cable to given terminal blocks. The cables shall be terminated by crimping lugs to the ends..

- 10.11.3.2 The various auxiliary equipments which are proposed to be installed in Vishnugad Pipalkoti HEP at various floors / locations where cable connections are required have been shown in the enclosed specification drawings.

10.11.4 Erection of Straight through joints

- 10.11.4.1 Straight through cable joints, wherever required shall be supplied and installed by the bidder. The bidder shall quote unit rates for straight through joints for different size of cables. The supply shall include necessary epoxy resin, jointing ferrules, tapes, plumbing material, etc. required for making the joint complete in every respect.
- 10.11.4.2 Where the cable is to be jointed with existing cable, the sequence of cores at the two ends to be jointed shall be in the opposite direction, i.e. if at one end it is in clockwise direction, at the other end it shall be in anticlockwise direction. This is necessary to avoid the crossing of cores while jointing.
- 10.11.4.3 Straight through cable joints for 11kV XLPE cables shall be constructed through proven technique and shall be complete with all accessories. Details of technique proposed to be adopted to install prefabricated joint shall be indicated in the bid.
- 10.11.4.4 When two or more cables are laid together, joints shall be arranged to be staggered by about 3 meters.
- 10.11.4.5 For straight through joints epoxy resin should be used. Jointing of cables shall be in accordance with relevant Indian Standards, Codes of Practice and manufacturer's special instruction including epoxy resin. Cables shall be firmly clamped on either side of a straight through joint at not more than 300 mm away from joints. Aluminium identification tags shall be provided at each joint and at all cable terminations. Single core cable joints shall be marked so that phase identity at each joint can be determined easily. The joints shall be located at most suitable places. There shall be sufficient overlap of cables to allow for the removal of cable ends

which may have been damaged. The design of the joint boxes must ensure that the actual insulation strength between phases and earth is greater than that of the associated cable and eliminate any possibility to moisture entering the joint or the compound surrounding the joint. Provision shall exist for bonding the sheaths of the two cables being joined solidly by approved means to ensure electrical continuity of sheath from one end of the cable run to other. Full details of the joint boxes and of the joints including dimensions shall be given by the contractor. The contractor shall take care while jointing the various cables that colour code of both sides should match to avoid confusion at both termination points.

- 10.11.4.6 Special tools, clips and saddles, glands, seals, PVC sealing compound, lock nut, etc. required for the connection and termination of cables including any special cables shall be supplied by the contractor. Cable shall not be fastened or clamped close to the point of entry of the equipment which may vibrate severely. Special instruction, if any, shall be strictly followed.

10.11.5 Erection of Cable trays, racks and support structures

- 10.11.5.1 Cable trays shall be fabricated of 14 gauge mild steel sheet of suitable width maximum five hundred (500) millimeters with sixty (60) millimeters sides and having oblong shape slots of 20 mm x 8 mm size throughout its length and height. The trays shall be ladder or perforated type.
- 10.11.5.2 Prefabricated fittings shall be used for changes in direction, elevation or size and field fabrication shall be limited to cutting straight sections for odd lengths only. Couplings and elbow plates between trays and fittings shall be firm without offset of sharp edges. The racks shall be of ISA 50x50x6 mm.
- 10.11.5.3 The entire tray and rack system will be electrically continuous & grounded by a GI flat of adequate size at five (5) metre intervals. Conduits joining the tray system will also be grounded there. Steel

trays and fittings shall be hot dip galvanized adequate size after fabrication. Minimum clearance between trays and walls shall be fifty millimeters.

- 10.11.5.4 Brackets for supporting the trays and racks shall be welded with steel supporting channels anchored to the walls or welded to embedded plates. The cable trays, racks, brackets, support structures shall be fully galvanized as per the relevant IS and the tack welded portion of trays shall be given a layer of epoxy paint or shall be treated with galvanised compound. Supporting structures shall permit position adjustment of trays or racks. All corners shall be as smooth as possible.
- 10.11.5.5 Required embedments in concrete will be done by others, however, the cable support structures shall be welded to above embedded plates or channels by the bidder . The bidder shall furnish the necessary embedment materials such as rock bolts & embedment plates etc. alongwith the detailed dimensional foundation drawings well in advance so that these can be fixed / embedded wherever required by the civil contractors. However, any additional embedments found necessary during erection/detailed engineering stage shall be done by the bidder without any additional cost.
- 10.11.5.6 The bidder shall furnish all the necessary elements to lay the cables through the anti fire partitions, floors and walls and the filling material to plug the holes.
- 10.11.5.7 Based on the cable routing drawing being supplied by the purchaser, the detailed engineering of tier-wise division or allocation of cable routes / cable schedule shall be made by the bidder in the relevant drawings and the same shall be submitted to the purchaser for approval.
- 10.11.5.8 The cable trays shall be laid on supports, the horizontal distance between supports shall be 1000mm. The top most cable tray in the cable trenches shall be provided with GI tray cover for mechanical protection of cables, Cable trays shall be tack welded to the cable

tray supports or provided with 'U' clamps and fixed to the cable tray supports.

10.12 EARTHING OF CABLES & ACCESSORIES

- 10.12.1 All bonding clamps at the joints and terminations of the armoured cables & the armour wires shall be solidly earthed. The clamps shall be adequately tightened. This is necessary to ensure proper electrical contact because armour is the only return path for earth fault current.
- 10.12.2 In case of unarmoured cables, the external metallic earth bonding connector of adequate size should be used. Precautions should be taken to eliminate the chemical and bimetallic corrosion of the earth connectors or bonds.

10.13 REQUIREMENT OF CONDUIT SYSTEM

- 10.13.1 Conduit system shall be complete with conduits of various types such as rigid metal conduits, non-metallic conduits & flexible conduits with boxes and fittings including all required hardware such as bolts, screws, hangers, concrete inserts, lock-nuts, clamps, bushings, coupling, pulling irons and identification tags etc.
- 10.13.2 Rigid metal conduits shall be fabricated of seamless, hot-dip galvanized steel. Fittings such as clamps and covers required for fixing metallic conduits shall also be galvanized.
- 10.13.3 The non-metallic conduits shall be of asbestos-cement for electrical purposes or PVC according to the relevant IS with standard segments of bends, joints, rubber rings, expansion couplings. etc. of approved type.
- 10.13.4 The flexible conduits shall be of hot-dip galvanized steel or PVC and in all cases these shall be liquid-tight.

10.13 INSTALLATION OF CONDUITS

- 10.13.1 Installation of all conduits, boxes, fittings and accessories shall meet the requirements of the relevant IS. Whenever the work is interrupted or upon completion, the conduit runs shall be sealed by the use of

plugs or caps and discs. Seals shall not be removed until the conductor is pulled in.

- 10.13.2 After installation the conduits shall be examined and cleaned by swabs, compressed air or by other methods, before conductors are pulled in. If a permanent block is found during checking or during installation of conductors, the conduit and surrounding concrete shall be replaced without additional expense to the purchaser. All boxes and fittings shall be kept closed and free from foreign matter and moisture.
- 10.13.3 Metal conduit runs shall be electrically continuous between boxes or equipment and grounded conduits shall be cut square with reamed ends. Conduit joints and threads shall be made thoroughly watertight and rustproof by means of the application of a non-insulating thread compound, such as white lead or equivalent, approved by the purchaser. All conduits terminating outdoors shall be sealed with a sealing compound as approved by the owner. Locknuts shall be used on both sides of slip holes to secure conduits entering boxes.
- 10.13.4 Concrete embedded conduit shall be sloped towards the drain points, and rigidly supported and braced during concrete placement. If required drain tees shall be installed at suitable low point with one end closed with fine brass mesh to facilitate drainage.
- 10.13.5 Conduits extending through floors, walls or beam shall be at right angles to the surfaces. Structural steel shall not be cut or drilled without prior written approval of the purchaser.
- 10.13.6 Conduits terminating at the face of concrete for extensions, shall end with plugged couplings flushed with the walls or floors and plugs shall also be provided for future conduit extensions.
- 10.13.7 Conduit boxes shall be installed parallel with building lines and flush with the finished surface. Conduit box covers and openings shall be easily accessible. All boxes shifted out of line during concreting or not properly installed, shall be removed and reset without additional expenses to the purchaser.

- 10.13.8 Conduit runs which are exposed shall be in straight lines parallel to column lines, beams or walls. Offsets shall be uniform and symmetrical. Support for exposed conduit shall be at intervals of not more than 1.5 meters for up to and including twenty one (21) millimeter conduit and not more than 3 meters intervals for twenty nine (29) millimeter conduit and over. Capped conduit and conduit terminating in boxes or fittings shall be supported approximately one hundred and fifty (150) millimeters from the terminal. Boxes and equipment housings shall be supported independently of the conduits.
- 10.13.9 Bending shall not reduce the conduit internal diameter or damage protective coatings. Bends having a minimum inside diameter ten percent (10%) less than the true diameter of the conduit, shall be rejected.
- 10.13.10 Permanent plastic tags bearing the conduit designation number shall be attached to each end and at junction and pull boxes. Samples of the proposed tags shall be submitted for approval to the purchaser. Where it is impractical to use tags, such as where conduits terminate at flush mounted boxes or other enclosures, the designations shall be painted inside the enclosure adjacent to the conduits.
- 10.13.11 All conduits in rooms with false ceiling shall be run concealed. Rooms with tiled walls shall have conduits concealed in walls or ceiling. In all other areas conduits can be either concealed or exposed type subject to the purchaser's approval.
- 10.13.12 Non-metallic conduits shall be installed as required with duct runs having a minimum pitch towards drainage location of twenty five (25) millimeters per one hundred (100) meters. Non-metallic embedded conduits shall be supported on spacers at maximum intervals of one (1) meter. Spacers shall be rigid & prefabricated type and no makeshift spacers shall be used. Field-cut conduit shall have machine tapered ends made with tools designed for the purpose. If nonmetallic conduit joints are to be installed, these should be

joined tightly with a compound recommended by the conduit manufacturer.

- 10.13.13 All conduit terminations shall be located as required. Where conduits enter equipment, cubicles or other enclosures, they shall be located by template. The accuracy of location shall be within ten (10) millimeters of the required dimensions, allowing proper spacing and clearances for fittings or attachment to devices. A reasonable amount of de-silting cutting, reaming and relocating holes shall be considered a normal part of the work. Conductors carrying AC & DC supplies shall not be bunched together in a conduit.
- 10.13.14 Unless otherwise specified, all non-metallic conduit shall be terminated with non-metallic end bells. All conduit terminations shall be sealed with compound harmless to cable and conduit.
- 10.13.15 Where rigid conduit cannot be used conveniently, short lengths of flexible steel or PVC conduit may be used for connection such as to conduit boxes or motors. Standard flexible conduit fittings shall be used for connection to rigid conduits and boxes. In wet locations and where exposed to the weather, liquid-tight flexible conduit and suitable fittings shall be used.

10.15 WASTAGES

- 10.15.1 Maximum percentage of wastages of materials that are allowed are as follows:
- i) Cables: 1% in respect of each type and size of cable. Cut pieces measuring 5 metres and above shall not be considered as wastage.
 - ii) Steel for fabrication 2%
 - iii) All other items Nil
- 10.15.2 All cut pieces against any of the item, where wastage is allowed, shall be the property of the purchaser only.

10.15.3 In case wastages are found to be more than the maximum percentage indicated above, the purchaser shall recover the cost of such additional wastages from the bidder's bills at the contracted rates.

10.15.4 Tolerance on drum length of cables shall be as per the relevant IS only.

10.16 CABLE MARKERS AND CABLE BINDING

Suitable cable markers of aluminium with punch marks shall be provided and suitably tagged to the cable permanently so that cable should be easily identified.

10.17 CABLE BINDING/STRAPPING

All control cables from glands shall be neatly routed and bonded with the help of cable straps and studs inside the panel. Complete routing in panel will be such that it gives a neat appearance and good workmanship.

For LT Power cables, suitable holding clamps will be provided in the panel if required.

10.18 ERECTION OF PANEL CUT-OUTS & GLAND PLATES

10.18.1 The panels (supplied by others) are provided with cable gland plates in the bottom. A few panels shall have top cable entry for cables. Suitable holes in bottom/top cable entry gland plates will be done by the bidder as required.

10.18.2 The bidder shall also be responsible for sealing the spare holes and panel cut-outs with the help of suitable gland plates or mutually agreed method. All materials are covered in the bidder's scope of supply.

10.19 CABLE ACCESSORIES

10.19.1 General

The bidder shall supply all the required accessories that may be found necessary during actual execution of the work within the quoted prices. No intermediate joint will be allowed in the run of

any cable, except for the case when the required length is more than the drum length.

10.19.2 Cable lugs

The bidder has to supply necessary lugs corresponding to the cable sizes given in the Schedule of Requirements. These shall be made of aluminium or copper corresponding to the conductor of cables. The bidder shall ensure that no bimetallic action takes place, between the aluminium conductor of the cable and the cable connecting lugs.

10.19.3 Cable Glands

The cable glands shall be double compression glands made of brass duly electrotinned in order to avoid corrosion and oxidation of the surface. The nipple threads shall be in accordance with IS 1653. Glands shall provide neat, tight, dust and vermin proof termination. Glands shall be provided with rubber ring to hold the cables firmly when check-nut is slightly tightened. Glands shall be complete with suitable washers etc. Cable glands shall incorporate built-in facilities for earthing the armour of cables.

10.19.4 Cable Marker Ferrules

The cable and wire markers shall be made of best quality material. Ferrules shall have deep, large and permanent marking of alfa-numerical symbols which can't be erased. Suitable sticker type ferrules for power cables may be supplied. These shall be marked as per purchaser's cable schedule such that each core of each cable can be identified easily.

10.19.5 Self Adhesive Marker

Self adhesive marker in the form of strips of any one character which can be easily peeled from the backing cards and can be applied on the cable shall be supplied. The strips shall be water-proof duly marked with a special formulated ink with specific thermo-setting adhesive to withstand high temperature.

Suitable plastic ring type ferrules marked with engraved indelible ink for control cables and sticker type ferrules for power cables shall be supplied. These shall be marked as per owner's cable schedule such that each core of each cable can be identified easily.

10.19.6 Tags

Aluminium strip of 19 mm width and 2 mm thickness for making tags or any other better alternative (details to be furnished with the bid) for labels shall be supplied.

10.19.7 Other Accessories

PVC tapes, cotton tapes etc. required for laying, termination, testing & commissioning shall be supplied. These materials & accessories shall be of good quality as per relevant IS.

All the accessories described in clause 10.25.9 shall be supplied and used by the contractor during the installation of cables. After the completion of work, at least 5 % of the quantities used of each of the following accessories but not less than 1 pc. of each type shall be handed over to the owner for future use.

Accessories	
i)	Termination kits for each cable size
ii)	Sealing ends for each cable size
iii)	Cable lugs for each cable size
iv)	Double compression Cable glands for each cable size
v)	Straight through joints for each cable size
vi)	Button Tape
vii)	Cable marker ferrules
viii)	Self adhesive marker
ix)	Aluminium Strips
x)	Cable trays & racks (for each type)
xi)	Cable junction boxes
xii)	Metal conduits, flexible conduits and PVC conduits (for each type)
xiii)	Cable rack supporting structure ((for each type)

10.20 SCHEDULE OF GUARANTEED & OTHER TECHNICAL PARTICULARS

Guaranteed & other technical particulars as per Annexure-I shall be furnished along with the bid. The particulars which are subject to guarantee shall be clearly marked. Any bid lacking complete information in this respect is likely to be rejected.

10.21 COMPLETENESS OF CONTRACT

The bidder shall be fully responsible for completeness of the contract including any item not mentioned explicitly but considered necessary to meet requirement of the work specified in these specifications and as per relevant IS and code of practice for electrical installation under Indian Electricity rules/Act.

10.22 WORK COMPLETION & DELIVERY SCHEDULE

10.22.1 The design & manufacturing works pertaining to cables, cable racks & accessories shall be carried out so that the delivery of all of these items to the project site would be completed before the date mutually agreed to start the execution work at site and the laying of cables, erection of cable racks, supports etc., testing and commissioning of the above items at site would be completed upto the completion date of the contract.

10.22.2 The bidder shall furnish PERT chart /deployment of manpower at site for the execution of various activities suiting above commissioning schedule at detailed engineering stage.

10.23 COORDINATION WITH OTHERS

10.23.1 The bidder shall coordinate in every respect and freely exchange necessary technical data with other suppliers/contractors as and when required under intimation to the purchaser to ensure proper coordination and completion of the work in time.

10.24 SCHEDULE OF REQUIREMENTS

10.24.1 The cables of all types & sizes shall have the following properties:

Oxygen index	Min. 29
Smoke density	Min. 40% light transmittance
Acid gas	Max. 20% by weight
Flame propagation	Shall meet IEC 332-1,2,3; IEEE 383 & SEN 4241475 (Class F 3)

10.24.3 Power Cables of 1100V Grade, multi-core cables

- 10.24.3.1 These cables shall be of 1100 volts grade, heavy duty, multi-core, stranded aluminium conductor (copper conductor for DC supply), HR-PVC insulated, colour coded, unarmoured or armoured, inner sheathed with extruded PVC, FRLS type conforming to IS 1554 (Pt. I). The outer sheath is of specially formulated PVC compound.

10.24.3.2 Cable Sizes

Sl. No.	Cable sizes No. of cores x mm ²	Voltage Grade
A.	Aluminium Conductor	
i)	3 ½ C x 300 / 150	1100 V
ii)	3 ½ C x 185 / 95	1100 V
iii)	3 ½ C x 150 / 70	1100V
iv)	3 ½ C x 120 / 70	1100 V
v)	3 ½ C x 95 / 50	1100 V
vi)	3 ½ C x 70 / 35	1100 V
vii)	3 ½ C x 50 / 25	1100 V
viii)	3 ½ C x 35 / 16	1100 V
ix)	3 ½ C x 25 / 16	1100 V
x)	4 C x 10	1100 V
B.	Copper Conductor	
xi)	2C x 70	1100 V
xii)	2C x 50	1100 V
xiii)	2C x 25	1100 V
xiv)	2C x 16	1100 V
xv)	2 C x 10	1100 V

10.24.4 Power Cables of 1100V Grade, single-core cables

- 10.24.4.1 These cables shall be of 1100 volts grade, heavy duty, single-core, stranded aluminium conductor , HR-PVC insulated, armoured / unarmoured , inner sheathed with extruded PVC, FRLS type conforming to IS 1554 (Pt. I). The outer sheath shall be of specially formulated PVC compound.

10.24.4.2 Cable Sizes

Sl. No.	Cable size No.of cores x mm ²	Voltage Grade
A.	Aluminium Conductor	
i)	1C x 800	1100 V
ii)	1C x 500	1100 V
iii)	1C x 400	1100 V
iv)	1C x 240	1100 V
v)	1C x 185	1100 V

10.24.6 Lugs for 1100V Grade Power Cables:

Adequate quantity of cable lugs not limited to the quantity as indicated below, for AC&DC power cables as specified under clauses 10.19.7 shall be supplied & erected at site by the bidder:-

- a) Lugs for 415V AC Aluminium Conductor Power Cables

Cable Size

800 mm²
 500 mm²
 400 mm²
 300 mm²
 240 mm²
 185 mm²

150	mm ²
120	mm ²
95	mm ²
70	mm ²
50	mm ²
35	mm ²
25	mm ²
16	mm ²
10	mm ²

b) Lugs for 220 V DC Copper Conductor Power Cables

Cable Size

70	mm ²
50	mm ²
25	mm ²
16	mm ²
10	mm ²

10.24.7 Cable Trays, Racks, Supports etc. of Required Sizes

Trays
400 mm 60 mm (ht.)
• Ladder type
• Perforated type
500 mm x 60 mm (ht.)
• Ladder type
• Perforated type
Racks
• ISA(50x50x6) mm
Rack/Ladder Covers
• Suitable for 400 mm racks
• Suitable for 500 mm racks
Supports
• Channel for Embedment
ISMC 150 with flange thk. of 9 mm and web thk. 6.5 mm)
ISMC 75(with flange thk. of 9 mm and web thk. 4.8 mm)
• Earthing Flat (50 x 6 mm GI flat)
• GI Flat (25 x 6 mm)

10.24.8 a) Cable Glands, Straight Through Joints for all types and sizes of power cables, as specified below:

1. Armoured Cable Glands

i)	1C X 400 mm ²
ii)	1C X 185 mm ²
iii)	2C X 70 mm ² (DC Copper Cables)
iv)	2C X 25 mm ² (DC Copper Cables)
v)	2C X 16 mm ² (DC Copper Cables)
vi)	3½C X 185/95 mm ²
vii)	3½C X 150/70mm ²
viii)	3½C X 120/70mm ²
ix)	3½C X 95/50 mm ²
x)	3½C X 50/25 mm ²
xi)	3½C X 35/16 mm ²
xii)	3½C X 25/16 mm ²

2. Un-armoured Cable Glands

i)	1C X 800 mm ²
ii)	1C X 500 mm ²
iii)	1C X 400 mm ²
iv)	1C X 240 mm ²
v)	1C X 185 mm ²
vi)	2C X 70 mm ² (DC Copper Cables)
vii)	2C X 50 mm ² (DC Copper Cables)
viii)	2C X 25 mm ² (DC Copper Cables)
ix)	2C X 16 mm ² (DC Copper Cables)
x)	2C X 10 mm ² (DC Copper Cables)
xi)	3½C X 300/150 mm ²
xii)	3½C X 185/95mm ²
xiii)	3½C X 150/70 mm ²
xiv)	3½C X 120/70 mm ²
xv)	3½C X 95/50 mm ²
xvi)	3½C X 70/35 mm ²
xvii)	3½C X 50/25 mm ²
xviii)	3½C X 35/16 mm ²
xix)	3½C X 25/16 mm ²
xx)	4 C X 10 mm ²

3. Straight Through Joint

i)	Suitable for 11 kV XLPE insulated 300 sq mm, armoured aluminium conductor cable
ii)	Suitable for 1.1 kV grade PVC insulated 70 sq mm, copper conductor, armoured DC power cable
iii)	Suitable for 1.1 kV grade PVC insulated 50 sq mm, copper conductor, armoured DC power cable

10.24.10 Other Accessories

- i) Cable glands, Straight through joints (wherever required), cable cleats / clamps etc. suitable for all type and sizes of cables shall be supplied & erected at site by the bidder.
- ii) Requisite quantity of couplings, elbow plates and other fitting accessories for cable trays / racks shall be supplied by the bidder.
- iii) GI flat of adequate size and its connection to entire tray and rack system at 5 m interval and further connection to earth mat shall be supplied by the bidder.
- iv) Brackets, rock bolts, embedment plates etc. supporting the tray & rack system shall be supplied as per requirement.

- v) The quantities of all items for supply and erection / laying of cables & accessories given above are only tentative & indicative and final quantities shall be as per layout drawings or as per cable routing drawing prepared by the bidder & approved by the purchaser during detailed engineering and / or as per changed route during erection. However, for the purpose of bid evaluation, above quantities shall be considered based on the unit rates quoted by the bidder. The required amendment in cable route shall be implemented into final drawings. The necessary work generated due to amendment shall be carried out by the bidder without any extra cost to THDC.

10.24.11 Control Cables

- 10.24.11.1 The control cables shall be of 650 V grade, heavy duty, multi-core, colour coded or core numbered, annealed high conductivity stranded copper conductor, insulated with HR PVC insulation, Un-armoured, PVC sheathed, FRLS, conforming to IS 1554 (Part-I & II). The outer sheath is of specially formulated PVC compounds.

S.No.	Cable Size No. of core x mm ²	Voltage Grade
1	4 core x 1.5 mm ²	650 V
2	7 core x 1.5 mm ²	650 V
3	16 core x 1.5 mm ²	650 V
4	4 core x 2.5 mm ²	650 V
5	4 core x 4 mm ²	650 V

10.26 SPARES

- 10.26.1 Mandatory spare parts for 5-years of normal operation period shall be quoted
- 10.26.2 Spare parts shall be identical to those used in the original equipment. These spare parts shall be subjected to the similar inspection and tests at works and shall be included in the same shipment as the complete equipment. These parts shall be packed in separate containers and clearly marked "SPARE PARTS".
- 10.26.3 Spare part code numbers and original manufacturer's designation shall be furnished to facilitate reordering.
- 10.26.4 The supplier shall indicate all special conditions required for long-term storage of spare parts.

Annexure-I**GUARANTEED AND OTHER TECHNICAL PARTICULARS**

Information asked below shall be furnished separately for all the cables, racks, trays, supports etc. in tabular form :

Sl. No.	Description of Items	Unit	Technical Particulars
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1. CABLES**1.1. General**

- i) Name & Address of the bidder
- ii) Name & factory address of the manufacturer
Validity of the tender
- iii) Cable type (11kV XLPE, 415V AC & 220V DC)
- iv) Standard applicable
- v) Suitability for earthed / unearthed system
- ii) Armoured/Unarmoured type

1.2. Conductor And Conductor Screen

- a) Material of conductor
- b) Nominal cross sectional area of the conductor mm²
- c) Form of conductor (circular/shaped)
- d) Minimum No. of strands
- e) Nominal dia of each strand (mm)
- f) Whether strands are tinned (Yes/No)
- g) Temperature coefficient of resistance at 20°C

1.3. Insulation

- a) Material
- b) Minimum average thickness (mm)
- c) Tolerance on thickness of insulation %
- d) Dia of core over insulation (mm)
- e) Minimum value of resistivity at 20°C MΩ
- f) Minimum value of resistivity at 70°C MΩ
- g) Core identification scheme
- h) Average dielectric strength kV/mm

Sl. No.	Description of Items	Unit	Technical Particulars
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- i) Suitability with regard to moisture, acid, oil and alkaline surroundings

1.4. Insulation Screen

- a) Whether extruded insulation screen is applied
b) Material of the insulation screen
c) Thickness of the insulation screen (mm)
d) Whether extruded under triple extrusion process

1.5. Armouring

- a) Armouring material
c) Thickness / dia of the steel tape / wire (mm)

1.6 Outer Sheath/Overall Covering

- .
a) Material
b) Whether extruded type
c) Minimum average thickness (mm)
d) Tolerance on the thickness of outer sheath (mm)
e) Dia of the cable under the sheath (mm)
f) Whether anti-termite treatment has been given in the outer sheath

1.7 Electrical Properties of Cables

- .
a) Maximum DC conductor resistance at 20°C (ohm/km)
b) Maximum DC conductor resistance at 70°C (ohm/km)
c) Maximum permissible conductor temperature (°C)
i) Under continuous full load condition
ii) Under transient loading conditions
d) Loss tangent (δ) at normal frequency
e) Reactance at 50 Hz (Ohm / km)
f) Capacitance at 50 Hz (F / km)
g) Guaranteed total power losses in each circuit without tolerance at maximum permissible conductor temperature. (KW)

(V)

Sl. No.	Description of Items	Unit	Technical Particulars
h)	Voltage Rating	(V / km)	
	i) Rated voltage		
	ii) Voltage drop per Km	(kVrms)	
i)	Dielectric Strength	(kVpeak)	
	i) Power frequency withstand voltage		
	ii) Rated impulse withstand voltage		
j)	Current Ratings		
	i) In air (continuous) at 38°C ambient temp.	(Amp)	
	ii) In duct (continuous) at 38°C ambient temp.	(Amp)	
	iv) Short circuit current rating for 1 sec.	(kA)	

1.8 Mechanical Properties of Cables

a)	Overall diameter of the cable	(mm)
b)	Diameter of the cable under the outer sheath	(mm)
c)	Diameter over the stranded core	(mm)
d)	Weight of cable per km	(kg)
e)	Total weight of non-metallic material	kg/metre
f)	Recommended minimum installation radius	
g)	Maximum safe pulling force	(Newton)
h)	Whether cable identification (marking) as per the specification is being provided	(Yes/No)

1.9 Cable Drum

a)	Over all dimensions of the drum	(mm)
b)	Total weight of the drum	(kg)
c)	Whether packing has been done as per the specification	(Yes/No)

2. CABLE ACCESSORIES

2.1 Cable Trays, Racks, Supports etc.

a)	Manufacturer's name	
b)	Address	
c)	Material specification	
d)	Maximum permissible loading weights with the proposed supporting arrangement	Kg/m
e)	Drawing showing arrangement and descriptive pamphlet enclosed	(Yes/No)
f)	Weight of zinc coating	(gm / m ²)

Sl. No.	Description of Items	Unit	Technical Particulars
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2.2 Conduit pipes (for each type & size)

- a) Manufacturer's name
- b) Address
- c) Applicable standards
- d) Material specifications
- e) Whether descriptive pamphlet enclosed (Yes/No)

2.3 Cable termination kit (for each size)

- a) Maker's name
- b) Full description and bill of material for the termination kit
- c) Whether termination kit is complete with all accessories (Yes/No)
- d) Whether descriptive pamphlet enclosed (Yes/No)

2.4 Cable Glands / Sealings (for each size)

- a) Type
- b) Material
- c) Manufacturer's name
- d) Address
- e) Whether descriptive pamphlets are enclosed (Yes/No)

2.5 Cable lugs (for each size)

- a) Type
- b) Material
- c) Manufacturer's name
- d) Address
- e) Whether descriptive pamphlets are enclosed (Yes/No.)

2.6 Straight through joints (for each type & size of cables)

- a) Manufacturer's name
- b) Address
- c) Whether complete with all accessories as specified (Yes/No)
- d) Whether descriptive pamphlets are enclosed (Yes/No)

Date:**Signature of the Bidder****Place :****Seal**

Annexure-II

SCHEDULE OF BOUGHT OUT ITEMS
(Makes to be specified. No equivalent is acceptable)

Sl. No.	Description	Make of Sub-vender	Remarks
1	2	3	4

Date:**Signature of the Bidder****Place :****Seal**

The bidder shall furnish here a list of similar equipment / goods supplied, installed and presently in operation.

Sl. No.	Order No. & Date	Purchaser	Year of Supply	Details of equipment / material supplied
1	2	3	5	6

Date:

Signature of the Bidder

Place :

Seal

Annexure-IV**SCHEDULE OF MANDATORY SPARES**

Sl. No	Item/Description	Make	Qty
1	2	3	4
1.	Spare cable lengths of each type and size of power cables used		5% of the total cable length but at least one length equal to the longest cable length used in the plant.
2.	Cable racks, trays, supports, embedment plats, conduits etc.		5% of the total scope of quantities of each type & size
3.	Other Accessories		
i)	Termination kits for each type and size of cable		5% of the total scope of each accessory but not less than 2pcs. of each item
ii)	Sealing ends / glands for each cable size		
iii)	Cable lugs for each type and size of cable		
iv)	Pre-fabricated straight through joints for each type and size of cables		
v)	Cable marker ferrules		
vi)	Self adhesive marker		
vii)	Aluminium strips		
viii)	Couplings, elbow plates, G.I. flats, brackets, rock bolts etc. (for each type)		
ix)			

Date:**Signature of the Bidder****Place :****Seal**

Annexure-V**SCHEDULE OF RECOMMENDED SPARES**

The bidder shall list here the recommended spare parts, if any, and quote the unit rates for the same.

Sl. No	Item/Description	Make	Qty
1	2	3	4

Date:**Signature of the Bidder****Place :****Seal**

Annexure-VII**SCHEDULE OF RECOMMENDED TOOLS & TACKLES AND TESTING EQUIPMENTS, IF ANY, REQUIRED FOR O&M AFTER COMMISSIONING**

Sl. No.	Description of Items	Make	Qty.	Purpose

Certified that the above tools and tackles are essential for maintenance of the equipment and the unit prices of these tools and tackles are furnished separately in the price schedule.

Date:**Signature of the Bidder****Place :****Seal**

Annexure-VIII**SCHEDULE OF INSPECTION, CHECKS AND TESTS ON MATERIALS & COMPONENTS AT WORKS (QAP)**

The various tests to be conducted on the equipment and its components shall be listed below by the bidder in sequential order in which these will be carried out. The purchaser, however, reserves the right to modify the sequence of these tests.

Sl. No.	Description of Tests	Reference	Remarks (CHP etc.)

Date:**Signature of the Bidder****Place :****Seal**

SECTION – 20

TECHNICAL SPECIFICATION OF LTAC SYSTEM

20.1 SCOPE

- 20.1.1 This section of specification covers the design, manufacture, assembly, testing at manufacturer's works before despatch, supply & services towards transportation, insurance, storage & preservation at site, erection, testing and commissioning & handing over, remedial action, if any upto defect liability period of 415V metal enclosed unit auxiliary & station auxiliary switchgears/boards suitable for indoor installation for providing AC supply to various equipment located at various floors in M/C hall cavern, transformer hall cavern, B.F. valve chamber, Surge shaft area, pothead yard, dam site, desilting chambers & TRT outfall areas etc. All inter panel cables and all other accessories required for its satisfactory operation as detailed here under and given in the schedule of requirements shall be covered in the Scope of supply.
- 20.1.2 The scope of supply for these AC distribution switchgears / boards also covers suitable over current, earth fault, under voltage / no-voltage protection relays for incoming, outgoing and motor feeder and tie incorporating interlocking scheme and air circuit breakers ~~as detailed under clause 20.7.21 & 20.7.22~~. The incoming/outgoing feeders shall be provided with air circuit breakers/moulded case circuit breakers as shown in the relevant drawing ~~enclosed as Section 30: "Tender Drawings" of Part-2: Section VI: "Employer's Requirement" in the bidding documents~~. The moulded case circuit breakers and low current outgoing feeder MCBs shall be suitably designed for thermal overload and magnetic short circuit protection. 0.415kV segregated/non-segregated three phase and neutral (TPN) bus-duct/bus bars of adequate size, nut, bolts etc. required for inter connection between 0.415kV metal clad switchgears, 0.415kV switchgears & SATs and for inter panel connections are also included in the scope of supply. Metering equipment consisting of volt meters, ammeters and energy meters shall be provided for all incoming feeder breakers alongwith current and potential transformers.
- 20.1.3 The scope of the supply also includes necessary special tools and plants required for erection and maintenance of these switchgears/boards. The bidder shall also list out in its bid, the details of tools and plants covered under the scope of supply. Any other equipment not explicitly mentioned herein/Schedule of requirement but is necessary for completeness & successful commissioning of equipment specified shall deemed to be included in the scope.

20.4. CODES AND STANDARD

All the equipment and materials shall be designed, manufactured, and tested, except where all modified and/or supplemented by the specification, in accordance with the latest applicable Indian Standard (IS) and the following IEC publications:

IEC 44-1	Instrument transformers – part 1: Current transformers
IEC 51	Directing acting indicating analog electrical measuring instruments and their accessories
IEC 158-1	Contactors
IEC 185/ IS2705	Current transformer
IEC 186/ IS 3156	Voltage transformer
IEC 255	Electrical relays
IEC 292	Motor starters

IEC 364-3	Electrical installations of buildings- Part 3: Assessment of general characteristics
IEC 408	Low voltage air break switches, air break disconnectors, air-break switch and fuse combination units
IEC 439	Low voltage switchgear and control gear assemblies
IEC 473	Dimensions for panel-mounted indicating and recording electrical measuring instruments
IEC 529	Degree of protection provided by enclosure
IEC 664	Insulation coordination within low voltage system
IEC 688	Electrical measuring transducers for converting ac electrical quantities to analog or digital signals
IEC 715	Dimensions of low voltage switchgear and control gear standardize mounting on rails for mechanical support of electrical devices in switchgear and control gear installations
IEC 865	Short circuit current – Calculation of effects
IEC 870-2	Telecontrol equipment and system – part 2: Operating conditions
IEC 898	Electrical accessories – Circuit breakers for over current protection for house hold and similar installations
IEC 947	Low voltage switchgear and control gear
IEC 1008	Residual current operated circuit breaker without integral over current protection for house hold and similar installation
IEC 1010	Safety requirements for electrical equipment for measurement, control and laboratory use
IEC 1200	Electrical installation guide (Selection and erection of electrical equipment) in switchgear and control gear
IS 375	Colour code of bus bar
IS 1293	Specification for three pin plugs and socket outlets
IS 1336/6875	Specification of push buttons, switches etc.
IS 2147	Specifications of metallic enclosure
IS 2148	Specification for flame proof enclosures of electrical apparatus
IS 2208 & IS 9224/9385	Specification of HRC cartridges and fuse links upto 650V
IS 2859 &	Specification of contactor for voltage not exceeding 1000V AC or 1200V IS 13947(IV) DC
IS 3231 &	Specification of electrical relays for power system protection
IS 8686	
IS 3659 &	Specification for heavy duty air circuit breakers for AC system

IS 8828/ 4064 / IS13947(II)	
IS 4237	Specification of low voltage switchgear and control gear
IS 5	Colour shades
IS 1554	Specification of PVC insulated heavy duty electrical cables
IS 1897	Chopper strips
IS 4064	Heavy duty air break switches & fuses of voltage not exceeding 1000V
IS 5578 & IS 11353	Marking and arrangement for switchgear bus bars main contacts and auxiliary wiring
IS 3072 IS 10118	Code of practice for installation & maintenance of and switchgear controlgear
IS 3202	Code of practice for climatic proofing of electrical equipment
IS 8623	Specification for factory built assemblies of low voltage switchgear for voltage upto and including 1000V and 1200V DC
IS 13947(I)	General requirement for switchgear and control gear for voltages not exceeding 1000V
IEC 298	AC metal clad switchgear
IEC 694	Common clauses for high voltage switchgear and control gear standards
IEC 60	High voltage test techniques
IEC 137	Bushings for alternating voltages above 1000V
IEC 233	Test on hollow insulators for use in electrical equipment
IEC 947-2	Low voltage switchgear and control gear
BS 159	Specification for high voltage bus bars and bus bar connections
IEC 73	Colours of indicator lights and push buttons
IEC 288	PVC insulated cables for switchgear and control gear wiring

Indian electricity rules 1956 and Indian electricity act 1910 (Section IV) latest rev. for electrical works.

Equipment and materials conforming to any other standard which ensures equal or better quality may be accepted. In such case, copies of the English version of the standard adopted shall be submitted along with the bid.

The electrical installation shall meet the requirements of Indian electricity rules as amended up to date and relevant IS code of practice.

In addition, other rules or regulations applicable to the work shall be followed. In case of any discrepancy, the more restrictive rule shall be binding.

The Tenderer shall furnish the schedule of recommended standards and codes in format of Annexure-4.

20.5 PROTECTION AGAINST EARTHQUAKE

Project is being located in an earthquake prone region of seismic zone IV (as defined in IS: 1893-fourth revision in 1984- Criteria for Earthquake resistant design of structure) of India which is prone to severe earthquakes. The equipments shall be designed for seismic co-efficient values of 0.38 g in horizontal direction and 0.19 g in vertical direction. To prevent equipments movement during earthquake, clamping device shall be provided for fixing the LT switchgears/boards to the foundation. Bidder shall supply necessary bolts for embedding in the concrete foundation. The arrangement shall be such that the LT switchgears/boards can be fixed to or unfastened from these bolts as desired. The fixing of the LT switchgear to the foundation shall be designed to withstand the seismic events. It will also be ensured that the clamping device as well as bolts shall not be overstressed. Details of the device used and its adequacy shall be furnished by the supplier and shall be subject to purchaser's approval.

20.6 TECHNICAL DATA & RATINGS

20.6.2 Other technical particulars to be considered for the detailed design of L.T. switchgears/boards are given below :-

1. Switchgear Cubicles & Bus-Bars

i)	Type	Metal enclosed, dust proof, air insulated, indoor-type
ii)	Protection class	IP-54
iii)	Rated system voltage	415 V $\pm$ 10%
iv)	Highest system voltage	1000V
v)	Phase system	3-phase, 4 wire system (3 phase + 1 neutral, Neutral section = 50% of phase section)
vi)	System earthing	Solidly earthed
vii)	System frequency	50 Hz $\pm$ 3%
viii)	Short time withstand current	50kA for all the panels
ix)	Dynamic breaking & making current	130 kA (peak)
x)	Insulation level - One minute power frequency withstand voltage for	
	a) Power circuits	2.5 kV (rms)
	b) Control Circuits	2.5 kV (rms)
xi)	Normal current rating of bus-bars	As per schedule of requirements
xii)	Control Voltage DC/AC Equipment	
	a) Closing	220V d.c. (80 - 110%)
	b) Tripping	220V d.c. (70 - 110%)
	c) Spring charging motors	220V d.c. (90 - 110%)
	d) Control voltage AC equipment	(240V $\pm$ 10%) V A.C. (240V $\pm$ 10%) V A.C.
	e) Service voltage AC equipment	

*** Note:** If D.C. control voltage is required the same be arranged through Individual power pack units (if required) of sufficient capacity for DC voltage requirement in B.F.V. Chamber, Pothead yard, Dam site & Desilting Chambers area shall have to be supplied by the bidder.

2. Air Circuit Breakers (ACBs) : Draw out type
 - i) Voltage : 3 phase, 415V $\pm$ 10 %
 - ii) Frequency : 50 Hz $\pm$ 3%
 - iii) Short Circuit performance category : P2
 - iv) Operating mechanism : Universal Motor operated, trip free & anti pumping device
 - v) Number of auxiliary contacts : 6 NO + 6 NC
 - vi) Rating of auxiliary contacts : 10A at 240V AC
 - vii) Temperature rise : As per IS: 13947
 - viii) Mechanical life : As per IS: 13947
 - ix) Operating mode : Local and Remote with auto manual facilities

3. Moulded Case Circuit Breakers (MCCBs) Draw out type
 - i) Voltage : 3 phase, 415V $\pm$ 10 %
 - ii) Frequency : 50 Hz $\pm$ 3%
 - iii) Short Circuit performance category : P2
 - iv) Operating mechanism : Manual, trip free
 - v) Number of auxiliary contacts : 6 NO + 6 NC
 - vi) Rating of auxiliary contacts : 10A at 240V AC
 - vii) Temperature rise : As per IS / IEC
 - viii) Mechanical life : As per IS / IEC

4. Miniature Circuit Breakers (MCBs) : Draw out type
 - i) Voltage : 240V $\pm$ 10 %
 - ii) Frequency : 50 Hz $\pm$ 3%
 - iii) Short Circuit performance : P2 Category
 - iv) Operating mechanism : Manual trip free
 - v) Temperature rise : As per IS / IEC
& Mechanical life :
5. HRC fuses : As per IS/IEC
6. Meters
 - i) Accuracy Class : 1.0
 - ii) One minute power frequency : 2.5kV rms
withstand voltage
7. Current Transformers
 - i) Type : Cast resin, primary bar type
 - ii) Secondary current : 5A & 1A.
 - iii) Voltage class and frequency : 650V, 50 Hz
 - iv) Class of insulation : B or better
 - v) Accuracy class and burden :
 - a) Accuracy class : Class 1, VA adequate for
(metering CT) application but not less than
15VA
 - b) Accuracy class : 5P, VA adequate for specific
(protection CT) application but not less than 15VA
 - c) Accuracy class : PS
(protection CT)
 - vi) Short circuit current : 50 kA for 1 sec.

- vii) Short circuit breaking & making current : 2.5 times of the short circuit rating

8. Voltage Transformers

- i) Type : Cast resin
- ii) Rated voltage
- a) Primary : $415 / \sqrt{3} \text{ V}$
- b) Secondary : $110 / \sqrt{3} \text{ V}$
- iii) Accuracy class
- a) Metering : 1.0
- b) Protection : 3P
- iv) Method of connection
- a) Primary : Star
- b) Secondary : Star
- v) Rated voltage factor : 1.1 continuous, 1.5 for 3 secs.
- vi) Class of insulation : B or better
- vii) One minute power frequency withstand voltage : 2.5kV (rms)

9. Relays :

- i) One minute power frequency withstand voltage : 2.5kV (rms)

20.7 SPECIFIC REQUIREMENTS FOR 0.415KV SWITCHGEAR EQUIPMENTS

The 0.415kV AC system consists of 0.415kV switchgears, connected with the respective station auxiliary transformers 11/0.433kV or unit auxiliary transformers 13.8/0.433kV.

The metal clad switchgear with incoming ACB shall be made with the busduct feeding from the respective dry type unit auxiliary or station

auxiliary transformers located in the common front with respective switchgear. Interface of metal clad switchgear and dry type transformers shall be under the scope of this specification.

Various panels forming part of the switchgear including dry type transformer at two ends of switchgear when assembled at site shall be of appearance of the continuous unit with flush appearance at the front without projections. It shall be unit type in construction. The design of the switchgear should be such that it gives a pleasing appearance, is compact in size and facilitates inspection and easy maintenance. The centre line of switches, push buttons, indicating lamps etc. and top line of instruments and relays etc. shall be matched to give a neat and uniform appearance. Necessary electrical clearances shall be maintained between live parts as well as live and earthed parts.

Adopter panels and dummy panels required to meet the various bus bar arrangement for connection between transformers and switchgear busbars shall be included in Tenderer's scope of work.

The dry type unit and station auxiliary transformers mounted in the cubicles and 0.415kV switchgear shall form a common panel board. Since the transformers are located near the inlet cubicles, the LT terminal of the transformers and switchgear buses shall be connected with copper buses inside the cubicles through seal off bushings. All accessories for connection with transformers shall be supplied by switchgear supplier. The supplier of LT switchgear shall coordinate with the supplier of dry type transformers for connections of the switchgear to the transformers.

20.7.1 Bus Bars and Support Insulators

- 20.7.1.1 The AC switchgear/board shall be provided with three phase and a neutral (TPN) bus bar system.
- 20.7.1.2 All the bus bar sections and jumper connections shall be made of high conductivity aluminium / aluminium alloy conductor of adequate size. The 415 volts aluminium bus bars shall be rectangular in cross section so as to be able to carry the required current within the limits of temperature rise at the site conditions. They shall be so designed and mounted in the chamber such that expansion or contraction does not effect either the bus bars or the insulating supports to any undue stresses. The bus bars shall be designed to withstand safely the dynamic forces due to short circuit. The size of neutral bus bar shall be 50% of phase bus bar and shall run continuously in the bus bar chamber and shall be connected at one point through disconnectable link to ground bus. Phase and neutral links shall be provided for individual feeders.

- 20.7.1.3 The cross section of the bus bars shall be uniform throughout the length of the switchgear/board and shall be adequately supported and braced to withstand the stresses due to the specified short circuit current.
- 20.7.1.4 All bus bars shall be adequately supported by Non-hygroscopic, non-combustible, track-resistant and high strength type polyester fibre glass moulded insulators/epoxy insulators. Separate supports shall be provided for each phase and neutral bus bar. If a common support is provided, anti tracking barriers shall be provided between the supports.
- 20.7.1.5 All bus bar joints shall be provided with high tensile steel bolts, belleville/spring washers and nuts, so as to ensure good contacts at the joints. Non-silver plated bus bar joints shall be thoroughly cleaned at the joint locations and suitable contact grease shall be applied just before making a joint.
- 20.7.1.6 All bus bars shall be colour coded as per IS: 375.
- 20.7.1.7 The bidder shall furnish calculations alongwith the bid, establishing the adequacy of bus bar size for specified current ratings. The same shall also be furnished during detail engineering for the approval of purchaser.
- 20.7.1.8 Auxiliary buses shall be provided for AC and DC control power supplies. The material for all auxiliary buses for control power supplies shall also be of high conductivity aluminium. The supply for AC auxiliary buses shall be tapped from the main power buses before the incomer for each switchboard. Individual fuse and neutral links shall be provided at each circuit of AC auxiliary bus bar. The circuit for control, space heater & cubicle light should include an isolating miniature circuit breaker (MCB) too. The auxiliary bus bar compartment shall also run horizontally.
- 20.7.1.9 The bus bars shall be provided with at least minimum clearance in air as specified in IS: 4237 for a 500V, 3 phase 4 conductor system.

20.7.2 Air Break Circuit Breaker (ACB)

- 20.7.2.1 The circuit breaker shall be triple pole, draw-out type and shall have inherent fault current breaking and making capacity as specified in clause 20.6 "TECHNICAL DATA & RATINGS".
- 20.7.2.2 Air Circuit breakers shall be mounted alongwith its operating mechanism on telescopic rails. The cradle should be designed and constructed so as to permit the smooth withdrawal and insertion of the breaker into it. The movement shall be free of jerks and shall preferably be on rollers and not on the flat surface. Suitable guides shall be provided to minimize the misalignment of the breaker.

- 20.7.2.3 All the three poles of the circuit breakers shall operate simultaneously in such a way that the maximum difference between the instants of contacts touching during closing shall not exceed half cycle of rated frequency.
- 20.7.2.4 The main contacts shall be appropriate copper and silver plating of the faces shall be 25 micron.
- 20.7.2.5 Arcing contacts should be of tungsten/graphite base alloy and must be separate from main contacts. One piece butt type contacts shall not be acceptable.
- 20.7.2.6 The ACB cubicle shall have door interlocking facility so that the cubicle door cannot be opened when the ACB is closed or in “Test” position. However interlock defeat arrangement shall also be provided. Inbuilt interlock should be provided to prevent the closed circuit breaker being inserted into the panel.
- 20.7.2.7 The ACB shall have provision of locking it in isolated position for keeping personnel and equipment safe during maintenance.
- 20.7.2.8 Automatic safety shutters shall be provided to ensure that the cradle terminals are completely covered when the circuit breaker is draw out position. Complete removal of the breaker from the switchgear panel/board shall be simple and smooth. When the cubicle door is closed, the breaker shall be able to achieve three different positions “SERVICE/ISOLATED/TEST POSITION”.
- 20.7.2.9 An auxiliary switch with 6 NO and 6 NC contacts shall be provided with each breaker and wired up to terminal block.
- 20.7.2.10 Air Circuit breaker shall be provided with motor operated spring charged mechanism. The motor shall be a universal motor suitable for operation from $240 \pm 10\%$ V AC. The charging time for closing springs shall not be more than 30 seconds. After failure of power supply, at least one open-close open operation shall be possible. Provision shall be made for emergency manual charging of closing spring.
- 20.7.2.11 Air circuit breakers shall be provided with closing and tripping coils. The closing coil shall operate correctly for voltage variation between 85% to 110% and trip coil for voltage variation between 70% & 110%.
- 20.7.2.12 Mechanical tripping shall be possible by means of front mounted red coloured trip push button. These push buttons shall be shrouded to prevent accidental operation.
- 20.7.2.13 Air circuit breaker shall be provided with mechanical indicating devices to show OPEN, CLOSE, TEST and SPRING CHARGED conditions.
- 20.7.2.14 Air circuit breaker shall be provided with no voltage release as it may be necessary to fulfill operation logic requirement.

20.7.3 Moulded Case Circuit Breakers (MCCB)

- 20.7.3.1 All the outgoing feeders (except where specifically mentioned) shall be provided with Moulded Case Circuit Breakers (MCCBs) having suitably designed for thermal over load and magnetic short circuit protection.
- 20.7.3.2 The MCCBs shall be mounted in a trolley which shall be of draw out type/plug- in type. The draw out mechanism for MCCBs shall be such that it shall be held in the cradle made of welded steel by means of two telescopic rails on which it shall be supported. These rails shall slide over ball bearings which shall make the movement of the MCCBs on the cradle extremely smooth.
- 20.7.3.3 MCCBs shall be manually operated. The operating handle should give a clear trip indication.
- 20.7.3.4 The MCCBs shall be quick make/quick break, trip free and independent of manual speed for operation.
- 20.7.3.5 MCCBs shall be fitted with direct acting magnetic thermal release for short circuit and overload protections. Settings of the thermal release shall be independently adjustable over a wide range of nominal rating in all ranges.
- 20.7.3.6 The MCCBs shall have a short circuit breaking capacity as given in clause 20.6.2 "TECHNICAL DATA & RATINGS".

20.7.4 Miniature Circuit Breakers (MCBs)

- 20.7.4.1 Miniature circuit breakers shall be designed in accordance with the requirements of IEC: 947.
- 20.7.4.2 MCBs shall be of double pole quick make and quick break type having both thermal over load and magnetic short circuit tripping devices with trip free mechanism. The contacts of MCBs shall be made of high corrosion and arc resistant material with silver layers to increase the life. It shall have non-ignitable, high impact plastic or fibreglass reinforced polyamide, precision moulded housing with universal surface suitable for flush mounting. Suitable arc chutes should be provided for quenching the arc in minimum time. The mechanism of the MCBs should not be influenced by environmental conditions. The MCBs shall have high rupturing capacity of not less than 10kA at 220V D.C. & 240V A.C. The tripping time on short circuit shall be less than 5 ms. Tripping characteristics of MCBs shall be submitted alongwith the bid.

20.7.5 Power Cable Terminations

- 20.7.5.1 LT power cables shall be taken out either from bottom or top of the switchgear panels in case of double front panels and either from bottom, rear or top of the switchgear panels in case of single front panels. Decision to this effect shall be taken at the time of final engineering of the drawings keeping in view of the blockouts already left in the layout floors. Purchaser reserves the right to alter the cable entries; if required during detail engineering, without any additional commercial implication.
- 20.7.5.2 Cable termination compartments and arrangement for power cables shall be suitable for stranded aluminium conductor, armoured/unarmoured PVC insulated and sheathed, single core / three and half core, 1100V grade power cables.
- 20.7.5.3 All necessary cable terminating accessories such as gland plates, supporting clamps and brackets, hardware etc. for purchaser's cables shall be provided by the bidder, to suit the final cable sizes which would be advised later.
- 20.7.5.4 The gland plate shall be of removable type and shall cover the entire cable alley. Bidder shall also ensure that sufficient space is provided for all cable glands. Gland plates shall be factory drilled according to the cable gland sizes and number which shall be informed to the supplier during detail engineering. For all single core cables, gland plates shall be of non-magnetic material.
- 20.7.5.5 Heat shrinkable sleeve on horizontal bus bars shall be provided but not in vertical bus bars.

20.7.6 Power Sockets / Portable Equipment Outlets

- 20.7.6.1 Three phase power sockets with grounding terminal for 400A, 250A, 150A, 63A & 32A have been envisaged for supply of power to portable equipment.
- 20.7.6.2 Power sockets shall be supplied with the fuse & switch as well as set of extension with flexible cable of the respective section.
- 20.7.6.3 The power sockets shall be with protection class IP 54 according to IEC 529.
- 20.7.6.4 The type of plug and socket for the power socket networks shall be as being specified by contractor of portable equipment and by the purchaser. The detail of such sockets shall be specified during detail engineering.

20.7.7 CONTROL CIRCUITS

Control circuits of incoming and sectionalized circuit breakers shall be provided with 220V DC.

Miniature circuit breakers with alarm contact for remote indication of tripped condition shall be provided for protection of the control circuits. The MCBs shall be of the fixed type for mounting on DIN rail. All means shall be provided for easy removal and handling of MCBs.

All MCBs shall be provided with necessary quantity of potential free contacts for specified indications, alarms and interlocks. All auxiliary contacts shall be wired to terminal blocks in the cable compartment.

Control switches for following control functions shall be provided for each incoming and sectionalized circuit breakers:

1. Local/remote mode of operation
2. Test-Normal-Close selector switch with pistol grip handle and key interlock for circuit breaker
3. Manual Open/Close operation
4. On/Off automatic change over unit

Auxiliary contacts for following remote indications shall be wired to terminal blocks:

1. Local/remote control mode selection
2. Test and connected position (each withdrawable assembly)
3. Circuit breaker trip condition (each withdrawable assembly)
4. Circuit breaker position (each withdrawable assembly)

20.7.8 METERING

All measuring equipment shall be located in the respective circuit breaker compartment. All metering circuits shall be terminated on marked terminal blocks for remote metering purpose. All meters, indicators control and selector switch shall be located in hinged door of this compartment.

On the door of switchgear are located:

1. One bimetal/moving iron movement ampere meter with selector switch for all incoming feeder.
2. One current transducer on all incoming feeder.
3. One voltmeter with selector switch for all incoming switch.

4. Voltage transducers for incoming and bus voltage.
5. One active energy meter for all incoming feeders in draw out cases with built in test facilities alternatively, these may have test block to facilitate testing of meter without disturbing CT or VT secondary connections. Active energy meters shall also have remote output.

Motor ammeter wherever required shall have an extended suppressed end-scale range to indicate starting current (5 to 8 times full load current)

Current measurements

Current transformers shall be mounted in the compartment with their respective feeder. Secondary leads of the current transformers shall be connected to marked terminals in the cable compartment in each cubicle. Secondary windings shall be earthed at one point only and means shall be provided on the equipment to facilitate the secondary circuit of the CTs being short circuited in the terminal blocks.

Voltage measurements

The secondary leads of the VTs shall be connected to MCBs with alarm contacts and wired to terminals. The secondary winding shall be earthed at one point only.

20.7.9 CUBICLES

The switchgear shall be indoor, air insulated, metal clad, floor mounting draw-out type, dust and water proof with vermin protection.

Switchgear enclosure shall confirm the degree of protection IP-54 according to the IEC 529. The minimum thickness of sheet metal used shall be 2mm. cubicles shall be in accordance with the recommendations of IEC 439.

The design shall be fully compartmentalized with metal/insulating partitions. The switchgear shall be comprise a continuous line up of single/multi tier cubicles. The installations of air circuit breaker at switchgear however shall be limited to the bottom two tiers only. All doors and covers shall be gasketed. All switchgear frames shall be fabricated using suitable mild steel structural sections or pressed and shaped with Cold rolled sheet steel of thickness not less than 2mm. doors and covers shall also be of Cold rolled sheet steel of thickness not less than 2mm. Stiffeners shall be provided ,wherever necessary. The panel shall be designed taking into account seismic effect of this area.

All panels edges and cover/door edges shall be reinforced against distortion by rolling, bending or by the addition of welded reinforcement member. The complete structure shall be rigid, self supporting free from flaws, twists and bends. All cutouts shall be true in shape and devoid of sharp edges.

Each cubicle shall have hinged door. The hinged doors shall be such as to allow the withdrawable type breakers to withdrawn to “Test” & “Isolate” position without opening the door and shall be interlocked so that it can not be opened unless the breaker is “Off” & “Isolate” position. It shall also not be possible to rack the breaker into service position unless the door is closed.

The switchgear shall be provided with supporting frame work and foundation bolts etc. to have proper leveling, additional channel iron frame of size 75mm x40mm x6mm for embedment in the floor concrete shall be supplied along with suitable size of foundation bolts. It shall be designed in such a way that switchgear when placed on the embedded frame and bolted, shall require no further fastening. The panels shall be fixed on the embedded foundation channel with provision to withstand earthquake with ground acceleration of 1.0g.

20.7.10 CURRENT TRANSFORMER

The current transformer shall be provided wherever specified. The CTs shall be designed and tested to comply in all respects to IS: 2705/IEC44-1 with latest amendments/additions.

The CTs shall be of the single phase, single/multi core, dry completely encapsulated cast resin insulation type. The CTs ratings shall be in accordance with general requirements, and the following additional requirements.

The secondary current of the CTs shall be 5A throughout. The capacity of each CT shall be chosen by the Contractor to suit the requirements of the connected apparatus and device, but shall not be less than 125% of the overall computed load on each core.

Other technical requirements/characteristics for different CTs have been indicated in Schedule of requirements/schematic drawings appended with these specifications.

These shall be able to withstand the thermal and mechanical stresses resulting from the maximum short circuit and momentary current ratings of the system. The core laminations shall be of high grade silicon steel. The maximum currents shall be as low as possible.

CTs shall have polarity marks indelibly marked on each transformer and at the lead terminations at the associated terminal blocks. Facility shall be provided for short circuiting and grounding the CT secondary at the terminal blocks. Characteristic curve for CTs are to be furnished by successful tenderer. It will be the responsibility of successful tenderer to match the CT characteristics of differential, REF CTs with those provided on LV side.

All secondary connections shall be brought out to terminal blocks where star or delta connection will be made.

Accuracy class of CTs shall be:

- Class PS for Differential (For incomer from transformer only)
- Class 5P20 for other relaying
- Class 1.0, ISF<5 for metering

20.7.11 VOLTAGE TRANSFORMER

The voltage transformers shall be designed and tested in accordance with IEC: 186/IS: 3156 (Latest revision). The VTs shall be of single phase, completely encapsulated cast resin insulated dry type transformers suitable for continuous operation at the temperature prevailing inside the switchgear enclosure when the switchgear in operating condition and the outside ambient temperature is 40 degree C.

The VTs ratings shall be in accordance with general requirements, and the following additional requirements.

- Primary Voltage $415/\sqrt{3}$ V
- Secondary Voltage, for metering $110/\sqrt{3}$ V
- Winding to be used for metering accuracy class 1.0

The capacity of the voltage transformers shall be chosen by the contractor to suit the requirements of connected apparatus and devices, but shall not be less than 125% of the overall computed burden of the apparatus connected to the respective winding. Vt mounted on breaker carriage is not acceptable.

High Voltage windings of VT shall be protected by current limiting fuse. The VT and fuses shall be completely disconnected and visibly grounded in fully draw-out position.

Low voltage fuses, sized to prevent overload, shall be installed in all ungrounded secondary loads. Fuses shall be suitably located to permit easy replacement while the switchgear is energized.

20.7.12 RELAYS

The protection and control relays shall be designed in accordance with the recommendations of IEC 255/IS: 3231, 8686 & BS: 142 and shall be suitable for operation under climatic conditions prevalent at site.

All relays may be of draw-out design with built in testing facilities. Small auxiliaries' relays may be of non draw-out type. Necessary test plugs shall be supplied loose and shall be included in contactors scope of supply.

Relays shall be rated for operation on 5A secondary current and 110V secondary voltage, number and rating of relays contacts shall suit the job requirements.

The contactor shall furnish, install and coordinate all relays to suit the requirement of protection, interlock and bus transfer scheme as broadly indicated in the annexure and drawings.

The contacts of all relay shall be capable of marking the maximum current which may occur in the circuit which they have to control. They shall also be capable of breaking such currents unless provision is made for breaking the current on contacts elsewhere in the circuit. Relays shall be affected by mechanical shock or vibration or by external magnetic fields consistent with the place or method of mounting. All relays which are connected to complete the tripping circuit of circuit breaker or the operating coil of a tripping relay shall be provided with operation indicators.

On relay elements indicators shall also be provided to enable the type or phase of the fault condition to be identified. Each indicator, whether of the electrically or mechanically operated type, shall be capable of being reset by hand without opening the relay case. Each indication shall be so designed that it can not be move before the relay has completed its operation, shall be clearly visible from the front when operated and shall be concealed at all other items. It shall not be possible to operate any relay by hand without opening the case.

All protective relays which initiate tripping shall have not less than two independent pairs of contacts of which one shall operate the tripping relays directly without the use or interposition of auxiliary contactors.

Relay having elements associated with particular phases shall be marked with phase identifications. The relay elements associated with phases R, Y & B or equivalent shall be mounted respectively left to right or top to bottom when viewed from front.

All relays shall be suitably marked with the following information:

- a) Phase colour of the current and / or voltage supply
- b) Function of relay e.g. over current.
- c) Rated current and/or voltage of the relay coils.
- d) Characteristic curve, where appropriate.

Space for client's reference marking item a) to c) shall be visible from the front without removing the cover.

In order to eliminate the effects of electrolysis, DC operating coils shall be so placed in the circuit that they are not connected to the positive pole of the battery supply except through contacts which are normally open. Auxiliary relays shall have sufficient number of pairs of contacts as required to complete the scheme. Contacts shall be silver plated with spring action. Relay cases shall have adequate number of terminals for marking potential free connections to the relay coils including spare contacts. Relay case size shall be so chosen as not to introduce any limitations on the use of available contacts of the relay due to inadequacy of terminals. Paralleling of contacts, if any, shall be done at the terminals on the casing of the relay.

Tripping relays shall be designed for the DC voltage specified and shall operate satisfactorily between 50% & 120% of the rated voltage. Voltage operated relays shall have adequate thermal capacity for continuous operation.

Timers shall be of the electromagnetic or solid state type but pneumatic timers are not acceptable. Short time delay in terms of milli-seconds may be obtained by using copper lugs on auxiliary relays and in such cases it shall be ensured that the continuous rating of the relay is not affected. Time delay in terms of milli-seconds obtained by external capacitor resistor combination is not preferred and shall be avoided to the extent possible. All timers shall be provided with externally hand reset positive action operation indicators.

No control relays which shall trip the power circuit breaker when the relay is de-energized shall be employed in the circuits. Provision shall be made for easy isolation of trip circuits of each relay for the purpose of testing and maintenance.

All relays shall withstand a test voltage of 2KV, 50 Hz RMS voltage for one minute.

Auxiliary seal in units provided on the relays shall preferably be of shunt reinforcement type.

Indication lamps should be located just above the associated push buttons/control switches. Red lamps shall invariably be located to the right of green lamps.

In case a white lamp is also provided, it shall be placed between the red and green lamps along the center line of control switch/push button pair. Blue and amber lamps should normally be located above the red and green lamps.

When associated with push buttons, red lamp shall be directly above the green push button and green lamp shall be directly above the red push button. All indicating lamps shall be suitable for continuous operation at 90 to 110% of their rated voltage.

All auxiliary relays with sufficient number of contacts for completion of the scheme, timer trip relays, indicating lamps, switches etc. for satisfactory operations of the equipment from local as well as from remote shall be included whether specified or not specified.

Relays may be direct acting or CT operated, depending on current rating.

20.7.13 METERS

The metering instruments shall be manufactured in accordance with IEC 51/IEC 473, IS: 1248/722.

All instruments and meters shall be suitable for operation under the climatic conditions prevailing at site. The instruments cases shall be dust proof, water tight, vermin proof specially constructed to adequately protect the instrument against damage or deterioration due to high ambient temperature and humidity.

Metering instruments shall be of the long scale 270° dial type with black graduations and numerals on a white back ground and antiglare glass. Frame dimensions shall be 96mmx96mm. Instruments mounted on panels shall be back connected. All instruments on a switch board or instrument panel shall be of matching pattern, shape and finish so as to present a pleasing appearance consistent with the functional requirements. The finish of the instrument case shall be subject to the approval of Owner.

The VA burden of the instrument coils shall be as low as possible consistent with best modern design.

Error shall not exceed 2% reckoned on the total length of the scale. Moving elements shall be provided with zero adjustments readily accessible from the front. The ampere-and voltmeters shall be able to handle 20% continuous overload. The Contractor shall submit scale, markings and name plates of all instruments for approval.

Ammeters and current coils of watt-meters shall continuously withstand 120% of rated current and 20 times rated current for 0.5 sec. without loss of accuracy. Voltmeters and potential coils of watt-meters shall withstand 120% of rated voltage continuously and twice the rated voltage for 0.5 sec. without loss of accuracy. Selector switch for each ammeter and voltmeter shall be provided to select current of each phase and phase to phase voltage respectively.

Motor ammeter shall have an extended suppressed end scale range to indicate starting current (5 to 8 time full-load current).

Watt-hour meter shall be provided in draw out cases with built-in test facilities. Alternatively, they may have test block to facilitate testing of meter without disturbing CT or VT secondary connections. Watt hour meter for the incoming feeders shall have pulse remote output for connecting to the energy metering system.

20.7.14 INDICATING LAMPS

The indication lamps shall be manufactured in accordance with IEC 947-5-1.

Indicating and signaling lamps shall be suitable for use in respective panels in accordance with the voltages used for signaling. Each lamp shall have a removable cap, which can be inscribed with text and shall be softened by the heat of the lamp.

Lamps shall be low-watt, filament type with series resistor and colored lens. Lens and lamps shall be replaceable from the front.

The lamp holders shall be suitable for panel mounting and rear terminal connections. All lamps on AC/DC as the case may be, shall be of the same type and design. Lamps shall have translucent lamp covers to diffuse light in required colours as described below. Each lamp holder shall be fitted with black inscription plate having white engraved letters.

Red	:	ACBs/MCCBs/MCBs close
Green	:	ACBs/MCCBs/MCBs open

White	:	Auto trip
Amber	:	For all healthy conditions e.g. control supply.
Violet	:	Circuit breaker spring charged.
Blue	:	For all alarm conditions (e.g. over load) Also for “SERVICE” & “TEST” position indicators.

20.7.15 CONTROL SWITCHES, PUSH BUTTONS AND OTHER ACCESSORIES CONTROL AND SELECTOR SWITCHES

The switching elements shall be manufactured in accordance with IEC 947-5-1

Selector and control switches shall be of rotary type. The switches and pushbuttons shall be provided with ample contact stages, suitable cam or block arrangement necessary for the control system functions.

Momentary switches shall be rotary buttons of the spring return type or push buttons.

Switches shall be suitable for use with 240V AC or 220V DC control voltage.

Circuit breaker control switches shall have three positions and shall be spring return to “NEUTRAL” from “CLOSE” and TRIP” positions and shall have pistol grip handles. They shall have at least two contacts closing in close position, and two contacts closing in trip position unless specified otherwise.

Ammeter and voltmeter selector switches shall have four stay-out positions with adequate number of contacts for three phase 4 wire system. These shall have oval handles. Ammeter selector switches shall have make before break type contacts to prevent open circuiting of CT secondaries. Contacts of the switches shall be spring assisted and shall be of suitable material to give a long trouble free service.

Make and carry continuously current rating of the contact shall be at least 10 Amp.

PUSH BUTTONS

Push buttons shall be of spring return, push to actuate type. Their contacts shall be rated to make continuously carry and break 10A at 240V AC and 0.5 A at 220V DC.

All push buttons shall have one normally open and one normally closed contact, unless specified otherwise. The contact faces shall be of silver or silver alloy.

All push buttons shall be provided with integral escutcheon plates marked with its function.

The colour of the button shall be as follows:

Green	:	Breaker Close
Red	:	Breaker Open
Black	:	For Overload reset.

HRC FUSES

HRC-Fuses shall have visible operation indicators.

HRC-Fuses shall be mounted on fuses carriers, which are mounted on fuse bases. Wherever it is not possible to mount fuses on carriers, fuses shall be directly mounted on plug in type of bases. In such cases one set of insulated fuse pulling handles shall be supplied with each switchgear.

HRC-Fuses rating shall be chosen by the tenderer depending upon the circuit requirements and these shall be subject to approval of Owner.

20.7.16 **CONTROL AND SECONDARY WIRING**

415V SG shall be fully wired at the factory to ensure proper functioning of control, protection, transfer and interlocking scheme. All SGs shall be supplied completely wired internally upto the terminal blocks ready to receive all inter-cubicle and inter panel wiring and connections between panels of same SG including all bus wiring for AC and DC supplies shall be provided by the tenderer.

Provision of remote “ON” & “OFF” indications of each ACB and MCCB shall be provided in the distribution boards.

Extra flexible wires shall be used for wiring to devices mounted on moving parts such as hinged doors.

All wiring shall be properly supported, neatly arranged, readily accessible and securely connected to equipment terminals and terminal blocks.

Internal terminations of stranded conductors shall be made with solder less crimping type tinned copper lugs which shall firmly grip the conductor, or by an equally suitable method. Insulating sleeve shall be provided over the exposed parts of lugs.

Suitable fuse and links/MCBs shall be provided to permit individual circuit isolation from bus wires without disturbing other circuit. All spare contacts of relays, switches and other devices shall be wired upto terminal blocks.

All internal wiring shall be done with flexible, 650/1100V grade, single core having colour coded PVC insulated switchboard wired with stranded copper conductors 2.5 mm² for control circuit, 4 mm² for VT circuits and 6 mm² for CT circuits.

Each wire shall be identified at both ends with Permanent markers bearing wire numbers as per Contractor's wiring diagram.

Wire termination shall be made with crimping type connectors with insulating sleeves. Wire shall not be spliced between terminals.

20.7.17 CABLE TERMINATIONS

LT power cables shall be taken out either bottom or top of the SG panels. Cabling chamber, cabling termination compartment of adequate size shall be provided at the rear /front of the SG for proper accommodation of incoming /outgoing cables.

Cable termination compartment and arrangement for power cable shall be suitable for stranded aluminium conductor, PVC insulated and sheathe, single core/three & half core unarmoured, 1100V grade power cable.

Cabling chamber should be so located and spaced so that it shall be possible to bring the cables direct through cut-out in floor. Cables termination shall be such that no cable bent is required in the cable chamber. Cut-outs shall not be available where there are RCC beams and the design of Switchgear shall be take care of this constraint. Bimetallic terminal connectors shall be used wherever required to avoid electrolytic effect.

The gland plate shall be removable type and shall cover the entire cable alley. Tenderer shall also ensure that sufficient space is provided for all cable glands. Gland plates shall be factory drilled according to the cable gland size and number which are indicated in the enclosed specification drawings.

However, the exact sizes and number shall be confirmed during detail design stage. For all single core cables, gland plates shall be of non magnetic materials.

The outgoing feeders shall be so arranged that heavy size cables are terminated preferably in the middle portion of the panel (height wise) to provide the space for fixing of cables and easiness of handling.

20.7.18 AC/DC POWER SUPPLY

The following power supplies shall be made available to each SG:
AC supply: from different SG sections with Change over unit
DC supply: Double feeder

Isolating switch fuse unit shall be provided at each SG for the incoming supplies, 4-pole, single throw for AC and 2-pole, double throw for DC.

Bus wires of adequate capacity shall be provided to distribute the incoming supplies to different cubicles. Isolating switch fuse units shall be provided to each cubicle for AC/DC supplies.

AC load shall be so distributed as to present a balance loading on the three phase supply system.

20.7.19 TROPICAL PROTECTION

All equipment, accessories and wiring shall have fungus protection, involving special treatment of insulation and metal against fungus, insects & corrosion.

Screens of corrosion resistant material shall be furnished on all ventilating louvers to prevent the entrance of insects.

20.7.20 PAINTING

All steel surfaces shall be sand blasted, grounded and picked as required to produce a smooth, clean surface free of scale, grease & rust.

After cleaning the surfaces shall be given a phosphate coating following by two coats of high quality primer and stoved after each coat.

ALL SGs/MCCs shall be finished in light grey shade No. 631 of IS: 5 (1961) with two coats of synthetic enamel paint. The base frame at the bottom of panel shall have store enamel grossy black finish. Sufficient quantity of touch-up paint shall be furnished for application at site.

20.7.22 PROTECTIONS

20.7.22.1 The minimum protections to be provided for deferent types of circuits are listed below:

- a) Incoming feeder 3-inverse time O/C relays (51) for phase fault
 1- Inverse time O/C relays (51N) for earth fault
 Restricted earth- fault protection (for LV station
 service transformer side only)
- b) Outgoing feeder 2-inverse time O/C relays (51) for phase fault
 1-inverse time O/C relays (51N) for earth fault
 1-U /V Relay
- c) Motor feeder 1-Motor protection relay (99) for protection against:
 -Thermal overload
 -Phase faults
 -Unbalance (Negative sequence)
 -Locked rotor
 -Earth faults

20.7.22.2 Apart from protection relays, each electrically operated breaker shall be provided with anti-pumping (94), trip annunciation (30), lockout (86) and trip supervision (74) relays. Lockout relay shall be hand reset type. Protection indicated in drawing under Section-30: "Tender Drawings" of Part-2: Section VI: "Employer's Requirement" is indicative. Protection scheme for LTAC system shall be finally decided during detail design stage.

20.7.22.3 Fuse failure relay shall be provided on secondary side of voltage transformer to monitor HV & LV fuses.

However, the bidder may suggest modifications to the 415 V station auxiliary schemes including Protections described as mentioned above.

20.7.23 REMOTE CONTROL & ANNUNCIATION PANEL

20.7.23.1 Only remote annunciation panel may be provided. No manual control of 415 V switchgears is required from control room. These switchgears shall have remote operation only from CCS. This annunciation panel may be made common for the entire power house where all information of all the units come alongwith the information of 415V switchgear. The manual controls are only from individual MCCs. However, emergency stop command of different feeders of MCCs may be provided on this panel if required.

It has been proposed to provide remote control, indications and annunciations etc. in the power house control room for the following equipment:

- 415 V incoming, interconnecting & outgoing air circuit breakers, moulded case circuit breakers, miniature circuit breakers

For ACB

- Annunciation for over current, earth fault, DC fail, No volt trip
- Indication & control for Breaker ON/OFF
- Metering –Ammeter, Wattmeter

For MCB & MCCB

- Annunciation for TRIP Indication
- Indication for ON & OFF
- Metering- Ammeter & wattmeter

For Bus

- Metering- Voltmeter, frequency
- Position & status of all the unit auxiliary, station auxiliary & station service transformers (indication & annunciation only)

- 20.7.23.2 The proposed remote control panel shall have ON / OFF / Fault trip, trip circuit healthy indicating lamps, close & open control push buttons, trip & non-trip alarm scheme.
- 20.7.23.3 The bidder shall furnish a complete schematic for ensuring complete remote control, indication / annunciation of aforesaid equipments.
- 20.7.23.4 The bidder shall furnish a complete list of the signals which are required for ensuring complete remote control, indication/annunciation of the aforesaid equipment with CCS and central alarm and annunciation panel to be supplied by other supplier.
- 20.7.23.5 The overall height of the remote control panel shall be as for the other switchgear panels.
- 20.7.23.6 Provision of remote "ON" & "OFF" indications of each ACB's, MCCB's and MCBs shall be provided in the switchgear cubicles / boards. Necessary control wiring from switchgear panel/board to RTU's for item numbers 1 to 11 in the schedule of requirement shall have to be carried out by the bidder. RTU's and optic fibre cable for this purpose shall also

be supplied by the bidder for remote control & monitoring of the LT Switchgear from remote control panel as well as from the operator station located in control room of power house.

20.7.24 AUTOMATIC CHANGE-OVER UNITS

The voltage control relay shall be designed in accordance with the recommendations of IEC 255.

The voltage control relays shall be for monitoring the 3 phase voltage. Characteristics of the voltage control relay shall be in accordance with the following requirements.

Rated voltage U_n	415 V AC
Adjustable upper voltage limit	0.75-1.05 U_n
Adjustable lower voltage limit	0.15-0.30 U_n
Adjustable reaction time	0.1-10 sec

In case of supply voltage drops to 80% or below on one of the section of SG (sensed by respective bus under voltage relay) and if such drop is not of transient in nature (to be checked by slave time delay relay to the above undervoltage relay) then the particular incomer breaker will trip automatically and such tripping shall be independent of any position of "On/Off automatic change-over" selector switch.

One (1) No. "On/Off automatic change-over" selector switch with two positions shall be provided on SG which would close the sectionalized circuit breaker automatically if:

- The "On / Off automatic change-over" selector switch in "On" position; Either of the two incomer breakers is open.
- The bus fault does not persist on unhealthy section of bus, the incomer breaker of which is open (to be checked by non-operation of lockout relay of corresponding incomer breaker).
- The voltage of the unhealthy section of bus is not more than 20% of the rated voltage and voltage of the other section of bus is more than 80% of rated voltage. (All these bus voltages shall be sensed by respective bus undervoltage relays, set at 20% and 80% settings)..

In case the automatic change-over does not take place within the present time (to be checked by slave time delay relay connected to 20% bus undervoltage relay) then all the outgoing motor feeder breakers of unhealthy section of bus shall be tripped due to undervoltage through lockout relay and auto changeover circuit. For closing the Bus coupler breaker shall also be blocked.

In this connection, it shall be specifically noted that tripping of all outgoing motor feeder breakers due to undervoltage shall be

independent of position selection of "On/Off automatic change-over" selector switch but shall be dependent on the sustained bus undervoltage condition ensured by time delay relay connected to 20% bus undervoltage relay.

The above changeover features shall be incorporated in the control schematics of incoming & sectionalized breakers.

20.7.25 Terminal Blocks

Terminal blocks shall be of 650 V grade rated for 10Amps and in one piece moulding. It shall be complete with insulating barriers, screw less cage clamp type/screw & stud type with identification strips. The latter type shall have screw locking design to prevent loosening of conductors under any severe conditions. Marking terminal strip shall correspond to the terminal numbering on wiring diagrams.

Terminal blocks for CT and VT secondary leads shall be provided with test links and isolating facilities. CT secondary leads shall be provided with short circuiting and earthing facilities.

In all circuit breaker panels at least 20% spare terminals for external connections shall be provided and these spare terminals shall be uniformly distributed on all terminal blocks. Space for adding another 10% spare terminals shall also be available.

All terminal blocks shall be suitable for terminating on each side, two (2) nos. of 2.5mm² size stranded copper conductors.

All terminals shall be numbered for identification and grouped according to the function. Engraved white on black labels shall be provided on the terminal blocks.

Wherever duplication of a terminal block is necessary it shall be achieved by solid bonding links.

Terminals blocks shall be arranged with at least 100 mm clearance between two sets of terminal block. The minimum clearance between the first row of terminal blocks and the associated cable gland plate shall be 250mm.

Self aligning, spring loaded, silver plated, sliding contacts of proven design shall be provided as control terminals for withdrawable/drawout modules. Detachable plug and socket type control terminals shall also be acceptable.

Terminal blocks shall be located to allow easy access. Wiring shall be so arranged that individual wires of an external cable can be connected to consecutive terminals.

20.7.26 Ground Bus

A ground bus of copper rated to carry maximum fault current, shall extend full length of the SG.

The ground bus shall be provided with two-bolt drilling with G.I bolts and nuts at each end to receive 60 x 10 mm GI flat.

Each stationary unit shall be connected directly to the ground bus. The frame of each circuit breaker and drawout V.T. unit shall be grounded through heavy multiple contacts at all times except when the primary disconnecting devices are separated by a safe distance.

Wherever the schematic diagrams indicate a definite ground at the SG a single wire for each circuit thus grounded shall be run independently to the ground bus and connected thereto.

C.T. & V.T. secondary neutrals shall be earthed through removable links so that earth of one circuit may be removed without disturbing others.

All hinged doors shall be earthed through flexible earthing braid.

All non-current carrying metal work of the distribution board shall be effectively bonded to the earth bus. Electrical conductivity of the whole distribution enclosure frames work and the truck shall be maintained even after painting.

The truck and air circuit breaker frame shall get earthed while the truck is being inserted in the panels and positive earthing of the truck and breaker frame shall be maintained in all positions i.e. SERVICE & ISOLATED, as well as through out the intermediate travel.

Each module frame shall get engaged to the vertical earth bus, before the disconnecting contacts on the module are 'engaged to the vertical busbar.

All metallic cases of relays, instruments and other panel mounted equipment shall be connected to earth bus by independent stranded copper wires of size not less than 2.5 mm. sq. Insulation colour code of earthing wires shall be green. Earthing wires shall be connected to terminals with suitable clamp connectors and soldering is not acceptable. Looping of earth connection is not acceptable which would result in loss of earth connections to other devices when a device is removed.

20.7.27 Name Plates

Nameplates of approved design shall be furnished at each cubicle and at each instrument & device mounted on or inside the cubicle.

The material shall be lamicoid or approved equal, 3 mm thick with white letter on black background.

The name plate shall be held with self-tapping screws. Name plate size shall be minimum 20 x 75 mm for instrument/devices & 40 x 150 mm for panels.

Each panel shall be provided with plastic mounted circuit diagram on the inside of the cubicle. Caution notice on suitable metal plate shall be affixed at the back of each vertical panel.

Suitable plastic sticker labels shall be provided for easy identification of all equipment located inside the panel/module. These labels shall be positioned so as to be clearly visible and shall give the device number, as mentioned in the module wiring drawings.

20.7.28 Space Heaters and Plug Sockets

Each SG shall be furnished with thermostat controlled space heater and 5A, 3 pin plug socket.

Space heaters shall be provided in the SG to prevent harmful moisture condensation. The space heaters shall be suitable for continuous operation on 240V AC, 50 Hz, single phase power supply.

Cubicle heater circuit shall be provided with individual switch fuse units/MCB.

20.8 TEMPERATURE RISE

The switchgear shall be designed to operate satisfactorily under the climatic conditions prevailing at site. The maximum temperature attained by any part of the entire equipment covered under this specification, at the specified ambient temperature shall not exceed the limits specified in the relevant Indian standard of the equipment.

20.9 Packing & Transport

The packing may be in accordance with the tenderer's standard practice but he shall give full particulars of packing for the approval of the purchaser. Special arrangement shall be made to facilitate handling and to protect projecting connections from damage in transit.

All parts shall be adequately marked to facilitate field erection. Boxes and crate shall be marked with the contract number and shall have a packing list enclosed, showing the parts contained therein.

During transportation of 415V LT switchgear to site, the supplier shall take all precautions/remedial measures to avoid any damage/accident etc. to transformer for timely completion of delivery at site. However, if due to any reason equipment falls down from the trailer the same will not be accepted by the purchaser and shall be replaced by new equipment without any extra cost to the purchaser.

20.10 INTERCHANGEABILITY

All similar parts of same design & rating fitted in switchgear shall be interchangeable.

20.11 ACCESSORIES

The following accessories shall be furnished along with the switchgear:

- a. Breaker lifting and handling truck.
- b. Device for slow opening and closing of breaker.
- c. Test cabinet with coupling cables for testing the breaker in draw out position.
- d. Breaker racking in/out handle (if required).

20.12 TESTS

20.12.1 Shop Tests

Each switchboard shall be assembled at the manufacturer's works with all apparatus, instruments, meters etc. connected and the various components shall be tested in accordance with the requirements of the relevant Indian Standards. These tests shall be performed in the presence of the owner's representatives.

The switchgear assembly and major components such as circuit breaker (ACBs, MCCBs), instrument transformers (CTs & VTs), relays shall be tested for all routine tests as per latest additions of relevant IS/IEC Standards.

20.12.1.1 0.415 kV Switchgear Assembly

Seismic test and type tests certificates as per relevant IS shall be submitted. If the same are not to the satisfaction of the owner, the performance which is missing shall be performed by the manufacturer at his own expense to the full satisfaction of the owner.

20.12.1.2 Non-segregated TPN bus duct

Type test report for the following tests shall be furnished along with the tender:

- d) Temperature rise test
- e) Insulation test
- f) Short circuit test
- g) Check of the protection circuits continuity
- h) Check of continuity of protection
- i) Seismic withstand test

20.12.1.3 Type test reports for other equipment

Type test reports from recognized test house in proof of having manufactured and tested similar equipment as per IS: 8623 (latest revision)/IEC: 439-1 shall be furnished before the supply of equipment.

Type test certificates for tests as per IS: 2516/IEC: 947-2 from a recognized test house in proof of quality of circuit breakers shall be furnished before the supply of equipment.

Type test certificates from a recognized test house as per IS: 2705, IS: 3156 and IS: 8686 in proof of- quality of current transformers, potential transformers and relays shall be before the supply of equipment.

20.12.2 Routine tests

All tests for 415V switchgear and its accessories shall be performed in the presence of owner's representatives, if so desired by the owner. The contractor shall give at least 30 days advance notice of the date when tests are to be carried out.

20.12.2.1 0.415KV switchgear assembly

All routine tests including the following tests shall be performed on each switchgear assembly as per relevant IS.

- a) Physical dimensional check & verification of apparatus
- b) Operation test of various apparatus
- c) High voltage test
- d) Insulation resistance test before and after HV test
- e) Tests for verification of calibration of releases
- f) Checking of protective measures & continuity of protective circuits

Various components of switchgear assembly such as ACB, MCCB, MCB, CTs, PTs, relays etc. shall be tested for routine tests in accordance with the relevant Indian Standards and test result

furnished.

The tests shall include but not necessarily limited to the following:

- a. Operation under simulated service condition to ensure accuracy of wiring, correctness of control scheme & proper functioning of the equipment.
- b. All wiring and current carrying parts shall be given appropriate high voltage test.
- c. Primary current and voltage shall be applied to all instrument transformers.
- d. Routine tests shall be carried out on all the equipment such as circuit breakers, instrument transformers, Relays, meters etc.

20.12.2.2 Non segregated TPN bus duct

All routine tests as per relevant IS/IEC including following test shall be performed by manufacturer.

Power frequency voltage with stand test

The bus section shall withstand the power frequency voltage of 2.5KV (rms) for one minute.

20.12.3 Site tests

When complete switchgear has been installed and is ready for operation at site, it will be tested to determine whether or not the requirements of these specifications have been fulfilled. A list of proposed tests in addition to the following tests to be carried out at site shall be indicated in the tender. The complete bus structure will also be subjected to dielectric test in accordance with the relevant standards

- a) Insulation test
- b) Sequence test
- c) Relay test
- d) Operation test

All switchboards shall be tested for automatic switch-over & interlocking as specified.

20.12.4 Test Certificates

Certified reports of all the tests carried out at the works shall be furnished in six (6) copies for approval of the Owner.

The equipment shall be dispatched from works only after receipt of

Owner's written approval of the reports.

Type test certificates on above equipment shall be furnished. Otherwise the equipment shall have to be type tested, free of charge, to prove the design.

- 20.12.5 The Tenderer shall furnish the schedule of inspection and tests in the format of annexure-9.

20.13 DRAWINGS, DATA & MANUALS

Drawings, Data & Manuals shall be submitted in triplicate with the bid.

20.13.2 To be submitted for Approval & Distribution

Four (4) copies of the following drawings, for each item shall be furnished for approval as part of the contract.

- a. Outline dimensional drawing of the 415V switchgear showing general arrangement, space requirement and bus duct/cable entry points, location of terminal connections, insulators, accessories, overall assembly dimensions & weights, method of supporting the equipment from the walls, ceilings and floors wherever applicable.
- b. Cross-section with parts list.

- c. Foundation/fixing details.
- d. Single line diagrams.
- e. Control schematics.
- f. Wiring diagrams.
- g. Assembly and sub-assembly drawings of the important auxiliary equipment.
- h. Sectional views showing the general, constructional features, operating mechanism etc.
- i. Drawings/data regarding maximum loading under short circuit conditions imposed by the bus-structure on the supporting concrete.
- j. Layout & cross sectional view of bus/bus-ducts, alongwith details of insulators, supporting structure for enclosures.
- k. Any other drawings or information needed by Owner for co-ordination with other equipment not covered in this specification.

Detailed technical particulars such as accuracy class, VA burden, knee point voltage, magnetizing current etc for CTs and VA burden, accuracy class purpose etc for VTs installed in various feeders, bus-bars of SGs may also be indicated in the table form in the drawing.

Seven (7) copies of drawings, including one reproducible copy shall be furnished after approval. At least one month prior to dispatch of equipment seven bound copies of manual covering instructions for installation, operation & maintenance of the equipment shall be furnished to the Owner. These manuals shall include marked erection drawings, assembly drawings, results of factory test, list of spares and description of all items/components etc..

The manual shall clearly indicate the installation method, check-up and tests to be carried out before commissioning of the equipment.

The Bidder may note that the drawings, data and manuals listed herein are minimum requirements only. The Bidder shall ensure that the other necessary write-ups, curves and information required to fully describe the equipment are submitted with his bid.

- 20.13.3 The Tenderer shall furnish the Schedule of drawings, catalogues, manuals and other relevant information in the format of Annexure-6.

20.14 Orders for Additional Equipment

The Owner reserves the right for placing the order for similar additional

equipment, if required at a later date, but during the currency of the order. The price variation formula applicable for such equipment shall also be mentioned in the tender.

20.15 Quality Assurance Programme

The supplier has to supply the equipment for 0.415KV LT switchgear of best quality. The supplier has to maintain quality control and assurance during the manufacturing of equipment as per the approved owner's quality assurance plans. For details please refer quality assurance plan document.

20.16 DELIVERY SCHEDULE

The Tenderer shall state the shortest delivery period he can guarantee, counting from letter of award as per format at annexure-10.

20.17 GUARANTEED AND OTHER TECHNICAL PARTICULARS

The guaranteed & other technical particulars as per Annexure-1 shall be furnished along with the tender. Any tender lacking complete information in this respect is likely to be rejected as in the absence of requisite information/data; it may not be possible for owner to evaluate the suitability & adequacy of the equipment.

20.19 SCHEDULE OF SPARE PARTS

The mandatory spare parts as indicated in the Annexure-2 shall be furnished by the bidder.

The bidder is required to furnish a list of recommended spare parts, if any, in the prescribed schedule as per enclosed format of Annexure-3.

All spare parts supplied shall be interchangeable and shall be of same material & workmanship as the corresponding parts of the main equipment.

20.20 COMPLETENESS OF EQUIPMENT

All fittings and accessories of the equipments which may not have specifically mentioned in these specifications, but are usually necessary for the completeness and successful commissioning of the above equipment, shall be deemed to be covered by the specification and shall be indicated and furnished by the bidder without any extra cost to the purchaser.

20.21 TOOLS & PLANTS, TESTING DEVICES, CONSUMABLES ETC.

The bidder shall supply one complete set comprising of all tools, special tools, Instruments & testing devices required for O&M of 0.415kV metal enclosed switchgears / boards and associated equipments. The price wise list of each tool shall be indicated in the price schedule.

The equipments, tools, devices, instruments & consumables required for site assembly, erection, testing & commissioning of 0.415 kV metal enclosed switchgears / boards shall be provided by the bidder without any extra cost to THDC.

The Tenderer shall furnish the tools, special tools and testing devices etc. in the format of Annexure-7.

20.22 GUARANTEED PERFORMANCE

The performance figures quoted in technical particulars sheets shall be guaranteed with in the tolerance permitted by relevant Standard. In case of failure of the equipment to meet the guarantee, the equipment may be liable for rejection.

ANNEXURE-1**SCHEDULE OF GUARANTEED AND OTHER TECHNICAL PARTICULARS**

Sl. No.	Description of Items	Unit	Data
----------------	-----------------------------	-------------	-------------

415V LT Switchgear**1. A) Panels / Boards (indicate separately for each type rating)**

i)	Manufacturer's name & country of manufacture		
ii)	Manufacturer's type & designation		
iii)	Applicable standard		
iv)	Rated operational voltage	V	
v)	Rated insulation voltage*		
	a) Highest system voltage	V	
	b) Power frequency withstand voltage	kV	
vi)	Rated voltage of auxiliary circuits	V	
vii)	Maximum operating voltage*	V	
viii)	Symmetrical short circuit current rating at rated voltage*		kA
ix)	Peak short circuit withstand current* kA _{peak}		
x)	Degree of protection		
xi)	Service conditions i.e. indoor or outdoor		
xii)	Overall dimensions of panel* (LxBxH)		mm
	a) Single front	-	
	b) Double front	-	
xiii)	Shipping dimensions of largest package (LxBxH)		mm
xiv)	Weight of panel	Kg	

- g) Single front
- h) Double front
- xv) Shipping weight of largest package Kg

1. B) Busbars (Indicate separately for each rating)

- i) Name of manufacturer
- ii) Conductor material
- iii) Cross-section mm²
- iv) Clearance between phases mm
- v) Phase-earth clearance mm
- vi) Rated short time current and its duration kA/sec
- vii) Dynamic current rating kA_(peak)
- viii) Rated continuous current at specified ambient temperature A
- ix) Maximum temperature rise over ambient temp. °C
- x) Applicable standards
- xi) Whether bus joints silver plated Yes/No
- xii) Material for phase barrier
- xiii) Voltage class for support and bushing insulators V

1. C) Bus Duct (indicate separately for each rating)

- i) Name of manufacturer
- ii) Type of bus-duct
- iii) Bus enclosure material
- iv) Size (thickness) of enclosure material mm
- v) Applicable standards

2. Air Circuit Breakers (indicate separately for each rating)

- i) Name of manufacturer
- ii) Manufacturer's type designation
- iii) Applicable standards
- iv) Number of poles Nos.
- v) Rated operational voltage V
- vi) Rated current A

vii)	Rated Frequency	Hz
viii)	Short circuit performance category	
ix)	Rated short circuit breaking current*	kA
x)	Rated short circuit making current*	kA
xi)	Rated short time withstand current for 1 second *	kA
xii)	Rated insulation voltage*	
	c) Highest system voltage	V
	d) Power frequency withstand voltage	kV _{rms}
xiii)	Thermal overload and short circuit releases	
	a) Whether C.T. operated/thermo magnetic type	
	b) Definite time lag	
	c) Total operating time for complete clearance of fault	
xiv)	Breaker Operating times*	ms
	a) Opening time	
	b) Making time	
	c) Arc duration	
xv)	Type and material of main contacts*	
xvi)	Type and material of arcing contacts*	
xvii)	Breaker Closing Device	
	a) Whether manual or motor operated	
	b) Whether the circuit breaker is fitted with making current release	
	c) Whether the circuit breaker is fixed trip or trip free type	
	d) Whether indication for individual release provided	
xviii)	Normal voltage of closing mechanism	V
xix)	Normal voltage of tripping mechanism or shunt trip	V
xx)	Power required at designated normal voltage to:	W

a)	Close the circuit breaker	
b)	Open the circuit breaker	
xxi)	Type and rating of spring charging motor	W
xxii)	Voltage of spring charging motor	V
xiii)	Emergency manual charging facility provided	Yes/No
xxiv)	Weight of circuit breaker complete with arc extinguishing medium mechanism	Kg
xxv)	Normal range of current setting	A
xxvi)	Overall dimensions (LxBxH)	mm
xxviii)	Following test certificates shall be enclosed -	
a)	Test certificate for P-2 category	
b)	Test certificate for mechanical life	
c)	Test certificate for temperature rise	
d)	Type test certificate short circuit withstanding capacity	

3. Moulded Case Circuit Breakers (indicate separately for each type of rating)

i)	Name of manufacturer and manufacturer's type designation	
ii)	Applicable standards	
iii)	No. of poles	
iv)	Rated operational voltage	V
v)	Normal current	A
vi)	Frequency	Hz
vii)	Short circuit performance category	
viii)	Rated short circuit breaking current*	kA
ix)	Rated short circuit making current*	kA
x)	Rated short time withstand current for 1 second*	kA

- xi) Rated insulation voltage*
 - a) Highest system voltage V
 - b) Power frequency withstand voltage kV
- xii) Overload and short circuit release :
 - a) Whether thermal over load adjustment provided and its range of adjustment
 - b) Whether magnetic short circuit protection adjustment provided and its range of adjustment
 - c) Definite time lag Sec
 - d) Total operating time for complete clearance of fault ms
- xiii) Type and material of main contacts*
- xiv) Type and material of arcing contacts*
- xv) Whether the circuit breaker is fitted with making current release
- xvi) Whether the breaker is trip free
- xvii) Weight of the circuit breaker Kg
- xviii) Overall dimensions of the breaker (LxBxH) mm
- xix) Breaker operating time* ms
 - a) Opening time
 - b) Arc duration for breaking current
- xx) The following test certificates shall be enclosed -
 - a) Test certificate for P-2 category
 - b) Test certificate for mechanical life
 - c) Test certificate for temperature rise
 - d) Type test certificate for short circuit withstand capacity

4. Miniature Circuit Breakers (indicate separately for each type of rating)

- i) Name of manufacturer and manufacturer's type designation
- ii) Applicable standards

iii)	No. of poles	
iv)	Rated operational voltage	V
v)	Normal current	A
vi)	Frequency	Hz
vii)	Short circuit performance category	
viii)	Rated short circuit breaking current*	kA
ix)	Rated short circuit making current*	kA
x)	Rated short time withstand current for 1 second*	kA
xi)	Rated insulation voltage*	
	e) Highest system voltage	V
	f) Power frequency withstand voltage	kV
xii)	Overload and short circuit release	
	g) Whether thermal over load protection provided	
	h) Whether magnetic short circuit protection provided	
	i) Total operating time for complete clearance of fault	
xiii)	Type and material of main contacts*	
xiv)	Type and material of arcing contacts*	
xv)	Whether the circuit breaker is fitted with making current release	
xvi)	Whether the breaker is trip free	
xvii)	Weight of the circuit breaker	Kg
xviii)	Overall dimensions of the breaker (LxBxH)	mm
xix)	Operating Time*	ms
	a) Opening time	
	b) Arc duration for the breaking current	
xx)	The following test certificates shall be enclosed -	

- a) Test certificate for P-2 category
- b) Test certificate for mechanical life
- c) Test certificate for temperature rise
- d) Type test certificate for short circuit withstanding capacity

5. **Current Transformers (indicate separately for each rating)**

(Give details separately for each type of CT)

- i) Name of manufacturer and manufacturer's type designation
- ii) Applicable standards
- iii) Rated voltage V
- iv) Frequency Hz
- v) Rated primary and secondary current Amp
- vi) Rated output VA
- vii) Accuracy class
- viii) Highest system voltage* V
- ix) Rated insulation level* (Power frequency withstand voltage) kV
- x) Rated short time thermal current* kA
- xi) Rated dynamic current* kA
- xii) Resistance of secondary winding* Ω
- xiii) Accuracy limit factor*
- xiv) Exciting current* mA
- xv) Instrument security factor
- xvi) Class of insulation
- xvii) Following type test certificates shall be enclosed:
 - a) Short time withstand current tests
 - b) Temperature rise test
 - c) Power frequency withstand tests on primary and secondary windings

6. **Potential Transformers (indicate separately for each class/rating)**

(Give details separately for each type of PT)

- i) Name of manufacturer and manufacturer's type designation
- ii) Applicable standards
- iii) Rated primary and secondary voltage V
- iv) Rated frequency Hz
- v) Rated output VA
- vi) Accuracy class
- vii) Highest system voltage* V
- viii) No. of phases and method of connection
- ix) Type of earthing (earthed or unearthed)
- x) Class of insulation
- xi) Following type test certificates shall be enclosed -

- a) Power frequency withstand tests on primary and secondary windings
- b) Temperature rise test

7. Over Current And Earth Fault Relays (50/64)

- i) Name of manufacturer and manufacturer's type designation
- ii) No. of over current relays per circuit breaker
- iii) No. of earth fault relays per circuit breaker
- iv) Current rating (1A or 5A) A
- v) Setting ranges A
- vi) Pick up current* (% of set value) A
- vii) Operating current* (% of set value) A
- viii) Dropout current* (% of set value) A
- ix) Time settings ms
- x) Burden on C.T. at various settings VA
- xi) C.T. requirements
- xii) Thermal rating A
- xiii) Accuracy
- xiv) Coil ratings of auxiliary units and its burden
A/VA
- xv) Contact ratings V/A
- xvi) Insulation withstand voltage* V
- xvii) Overall Dimensions (LxBxH) mm

8. Voltage Relays

- i) Name of manufacturer and manufacturer's type designation
- ii) No. of voltage relays per circuit breaker
- iii) Voltage rating V
- iv) Voltage setting ranges V
- v) Pick up voltage (% of set value)* V
- vi) Operating voltage (% of set value)* V
- vii) Dropout voltage (% of set value)* V
- viii) Time setting ranges ms
- ix) Burden per phase on the potential transformer VA
- x) P.T. requirements
- xi) Thermal rating A
- xii) Accuracy
- xiii) Coil ratings of auxiliary units' i.e .voltage, burden
V/VA
- xiv) Contact ratings V/A
- xv) Insulation withstand voltage* kV
- xvi) Overall Dimensions (LxBxH) mm

9. Tripping Relay

i)	Name of manufacturer and manufacturer's type designation	
ii)	Coil ratings	V/A
iii)	Voltage band for satisfactory operation	V
iv)	Operating time	ms
v)	Burden	VA
vi)	Thermal rating	A
vii)	Contact ratings	V/A
viii)	Insulation withstand voltage*	kV
ix)	Overall Dimensions (LxBxH)	mm

10. Fuses

i)	Make	
ii)	Type	
iii)	Applicable standards	
iv)	Rated voltage	V
v)	Rupturing capacity*	kA
vi)	Peak cut off current*	kA
vii)	Whether mounted on an insulated carrier	

11. Auxiliary Contactors

i)	Make	
ii)	Type	
iii)	Coil voltage	V
iv)	Coil burden	VA
v)	Operating time	ms
vi)	Nos. of contacts (NO+NC)	
vii)	Current rating of contactors*	A

12. Control / Selector Switches

i)	Make	
ii)	Type designation	
iii)	Voltage grade	V
iv)	Current rating*	A
	a) Continuous rated current	
	b) Making current	
	c) Breaking current	
v)	Spring return or stay put type	
vi)	Type of handle	
vii)	No. of positions	
viii)	No. of poles/way	
ix)	Contact materials and plating	

13. Voltmeter

- | | | |
|------|---------------------|----|
| i) | Make | |
| ii) | Type | |
| iii) | Accuracy class | |
| iv) | Voltage coil rating | V |
| v) | Voltage coil burden | VA |
| vi) | Case size | mm |

14. Ammeter

- | | | |
|------|---------------------|----|
| i) | Make | |
| ii) | Type | |
| iii) | Accuracy class | |
| iv) | Current coil rating | A |
| v) | Voltage coil burden | VA |
| vi) | Case size | mm |

15. Indicating Lamp

- | | | |
|------|------------------------------------|-------------|
| i) | Make | |
| ii) | Type | |
| iii) | Voltage | V |
| iv) | Series Resistor – Rating and Value | A/ Ω |

16. Push Buttons

- | | | |
|------|---------------------------|---|
| i) | Make | |
| ii) | Type designation | |
| iii) | No. of contacts (NO + NC) | A |
| iv) | Contact current rating | |

17. Space Heater

- | | | |
|------|--------------------------|--------------------|
| i) | Make | |
| ii) | Type | |
| iii) | Rated voltage | V |
| iv) | Heater output | W |
| v) | Thermostat setting range | $^{\circ}\text{C}$ |

18. Wiring And Terminal Blocks

- | | | |
|------|------------------------|---|
| i) | Voltage grade of wires | V |
| ii) | Insulation of wires | |
| iii) | Conductor material | |

- iv) Minimum size of conductor for mm²
 - a) Power wiring
 - b) Control wiring
- v) Make and type of terminal blocks
- vi) Minimum current rating of terminal blocks

19. Timers

- i) Manufacturer's name
- ii) Type
- iii) Standard applicable
- iv) Range sec.
- v) No. of contacts (NO+NC)

20. Energy Meter

- i) Make
- ii) Type
- iii) Accuracy class
- iv) Voltage coil rating V
- v) Current coil rating A
- vi) Burden VA
- vii) Case size mm

21. Power Pack Unit

- i) Manufacturer's name
- ii) Capacity A/V
- iii) Capacity of charging unit A
- iv) Nos. of feeders in distribution board

22. Programmable Logic Control Unit

- i) Manufacturer's name
- ii) No. of input units
- iii) Power pack unit built in or otherwise
- iv) Capacity of unit
- v) Type of analog to digital converter
- vi) Details of computer and other processing unit
- vii) Type of control & signal cables

23. Intelligent Protection & Control System

Following technical particulars for Intelligent Protection & Control System shall be furnished

by the bidder

- i) Type
- ii) Make
- iii) Rated voltage
- iv) Rated current
- v) Digital input / output
- vi) Protection setting range
- vii) Conforming standard
- viii) Dimensional details
- ix) Features for control
- x) Features for protection
- xi) Features for metering
- xii) Test voltage / current
- xiii) Literature enclosed

24. Power Sockets / Outlets

- i) Type
- ii) Make
- iii) Rating

Note : Items with “*” marked are guaranteed particulars

Date :
Bidder

Signature of

Place:

Stamp

ANNEXURE – 2**SCHEDULE OF MANDATORY SPARES FOR 0.415 KV METAL ENCLOSED SWITCHGEARS / BOARDS**

Sl. No.	Description of Items	Quantity	Make
1.	415V completely assembled ACBs	10% of each type but not less than one	
2.	415 V MCCBs	10% of each type but not less than one	
3.	240 V AC, MCBs	10% of each type but not less than one	
4.	220V DC MCBs	10% of each type but not less than one	
5.	Spares for ACBs 1 No. Each of following		
	i) Main Contacts		
	ii) Arcing contacts		
	iii) Trip coils		
	iv) Closing coils		
	v) Spring charging mechanism complete with motors		
	vi) Closing & tripping springs		
	vii) Auxiliary contact assembly		
	viii) Local/Remote selector switch		
6.	Relays		
7.	CTs		
8.	PTs		
9.	Voltmeters		
10.	Ammeters		
11.	KWH meters		
12.	Glass covers for relays with rubber gaskets		
13.	Glass covers for measuring instruments with rubber gaskets		
14.	Indicating lamps		
15.	Indicating lamp assembly (W/O lamp)		
16.	Glass dome covers of different colours		

17. Fuse units
18. Push buttons
19. Contactors
20. Timers
21. Terminal blocks
22. Brass screws
23. Spring washers
24. Ferrules
25. Auto-manual switches
26. Bus bar supporting insulators fittings
27. Strip heaters
28. Thermostats for heaters

**Date :
Bidder**

Signature of

Place:

Stamp

ANNEXURE – 3**SCHEDULE OF RECOMMENDED SPARES FOR 0.415 KV METAL ENCLOSED SWITCHGEARS / BOARDS**

The bidder shall recommend the quantities of spares and accessories required for five years of normal operation and quote the rates accordingly.

Sl. No.	Description of Items	Quantity	Make
Remarks			

Date :
Bidder

Signature of

Place:

Stamp

20-84

Vishnugad Pipalkoti Hydroelectric Project

ANNEXURE-4**SCHEDULE OF STANDARD AND CODES**

Sl. No.	Subject/Title	Reference standard/Codes

Date :
Bidder

Signature of

Place:

Stamp

ANNEXURE-5**SCHEDULE OF DRAWINGS, CATALOGUES, MANUALS AND OTHER RELEVANT INFORMATION**

Sl. No	Title		Remarks

Date:**Signature of Bidder****Place:****Stamp**

Annexure-6**LIST OF TOOLS / SPECIAL TOOLS AND ACCESSORIES**

Sl. No.	Item/Description	Make	Quantity

Date:**Signature of Bidder****Place:****Stamp****20-87**

ANNEXURE-7**SCHEDULE OF INSTALLATION**

The Tenderer shall furnish the list of similar equipment supplied by him which is presently in service.

Sl. No.	Name & address of the customer	Place of installation	Year of supply	Particulars of switchgear

Date:**Signature of Bidder****Place:****Stamp****20-88**

ANNEXURE-8**SCHEDULE OF INSPECTION AND TESTS**

Sl. No.	Description	Remarks
A.	Test & inspection at work	
B.	Tests & Inspection at Site	

Date:**Signature of Bidder****Place:****Stamp**

ANNEXURE-9**SCHEDULE OF DELIVERIES AND COMPLETION PERIOD**

(Earliest delivery period for the equipment shall be specified)

Sl. No.	Description	Earliest Period
1.	Period required to commence work from tender acceptance (issue of letter of intent)	
2.	Period of supplying drawing for approval	
3.	Period when equipment will ready for inspection	
4.	Period when equipment will ready for dispatch	
5.	Period when equipment will receive at site	
6.	Period by which the equipment will completely erected and ready for use	

Date:**Signature of Bidder****Place:****Stamp**

INSTRUMENTATION CABLE														
ITEMS	TESTS													
	Conductor Resistance ® & (A)	High Voltage ® & (A)	Insulation Resistance ® & (A)	Constructional detail, dimensions (A)	Outer-Sheathe/core marking, end sealing (A)	Thermal Stability (A) +	Visual, Surface finish (A) +	Electrical Parameters ** (A) +	Persulphate Test (A) +	Overall/Coverage/Continuity (A)	Swidesh chimney Test (SS-4241475) (A) ++	FRLS Test * (A) ++	Tensile & Elongation before & after aging (A)	Vol. Resistivity. at room & Elevated Temp. (A)
1. Instrument cable twisted and shielded														
Conductor(IS-8130)	Y			Y			Y							
Insulation(VDE-207)				Y	Y	Y	Y						Y	Y
Pairing/Twisting				Y	Y		Y							
Shielding				Y			Y			Y				
Drain wire	Y			Y			Y		Y	Y				
Inner Sheath				Y	Y	Y	Y					Y	Y	
Outer Sheath				Y	Y	Y	Y					Y	Y	
Over all cable	Y	Y	Y	Y	Y		Y	Y			Y			Y
Cable Drums(IS-10418)				Y			Y							
Note : High Temp. cables shall be subjected to tests as per VDE-207 (Part-6) Compensating cables shall be checked for Thermal EMF/Endurance test as per IS 8784. Note : This is an indicative list of tests/checks. The manufacture is to furnish a detailed Quality Plan indicating his practice & Procedure along with relevant supporting documents during QP finalization for all item. Note : ® - Routine Test A - Acceptance Test Y - Test Applicable Note : Sampling Plan for Acceptance test shall be as per IS 8784 (As applicable) * FRLS Tests: Oxygen / Temp Index (ASTM D-2863), Smoke Density Rating (ASTM – D 2843), HCL Emission (IEC-754-1) ** Characteristic Impedence, Attenuation, Mutual Capacitance, Cross Talk (As applicable) + Sample size will be One No. of each size/type per lot. ++ Sample size will be One No. sample for complete lot offered irrespective of size/type.														

E.11. INDUCTION MOTOR & SYNCHRONOUS MACHINE

(Pg 1 of 2)

TESTS/CHECKS TEMS/COMPONENTS	Visual	Dimensional	Make/Type/Rating/TC/General Physical Inspection	Mech/ Chem. Properties	NDT /DP/MPI/UT	Metallographic	Electrical Characteristics	Welding/Brazing(WPS/PQR)	Heat Treatment
Plates for stator frame, end shield, spider etc.	Y	Y	Y	Y					Y
Shaft	Y	Y	Y	Y	Y	Y			Y
Magnetic Material	Y	Y	Y	Y	Y		Y		
Rotor Copper/Aluminum	Y	Y	Y	Y		Y	Y		Y
Stator copper	Y	Y	Y	Y			Y		Y
SC Ring	Y	Y	Y	Y	Y	Y	Y	Y	Y
Insulating Material	Y		Y	Y			Y		
Tubes for Cooler	Y	Y	Y	Y	Y				Y
Sleeve Bearing	Y	Y	Y	Y	Y				Y
Stator/Rotor, Exciter Coils	Y	Y	Y				Y	Y	
Castings, stator frame, terminal box and bearing housing etc.	Y	Y	Y	Y	Y			Y	
Fabrication & machining of stator, rotor, terminal box	Y	Y			Y				Y
Wound stator	Y	Y					Y	Y	
Wound Exciter	Y	Y					Y	Y	
Rotor complete	Y	Y					Y		
Exciter, Stator, Rotor, Terminal Box assembly	Y	Y					Y		
Accessories, RTD, BTD,CT, Brushes, Diodes,Space heater, antifriction bearing, cable glands, lugs, gaskets etc.	Y	Y	Y						
Motor (IS 325 / 4722/ 9283)	Y	Y	Y						

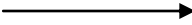
E11. INDUCTION MOTOR & SYNCHRONOUS MACHINE

(Pg 2 of 2)

TESTS/CHECKS ITEMS/COMPONENTS	Magnetic Characteristics	Hydraulic/Leak/Pressure Test	Thermal Characteristics	Run out	Dynamic Balancing	All tests as per IS-325/IS-4722 / 9283	Vibration	Over speed	Tan delta, shaft voltage & polarization index test
Plates for stator frame, end shield, spider etc.									
Shaft									
Magnetic Material	Y		Y						
Rotor Copper/Aluminum									
Stator copper			Y						
SC Ring									
Insulating Material			Y						
Tubes for Cooler		Y							
Sleeve Bearing		Y							
Stator/Rotor, Exciter Coils									
Castings, stator frame, terminal box and bearing housing etc.									
Fabrication & machining of stator, rotor, terminal box									
Wound stator									
Wound Exciter									
Rotor complete				Y	Y				
Exciter, Stator, Rotor, Terminal Box assembly									
Accessories, RTD, BTD, CT, Brushes, Diodes, Space heater, antifriction bearing, cable glands, lugs, gaskets etc.									
Motor (IS 325 / 4722 / 9283)						Y	Y	Y	Y1

Note:

1. This is an indicative list of tests / checks. The manufacturer is to furnish a detailed quality plan indicating the Practice and procedure along with relevant supporting documents during QP finalization for all the items.
2. All major Bought Out Items will be subject to Owner's approval.
3. Any other tests mentioned in the equipment specification are also to be carried out.
4. The codes and standards mentioned in equipment specification is governing.

LT SWITCHGEAR														(Pg 1 of 2)	
(MCC, PCC, ACDB, DCDB, FUSE BOARDS, LOCAL PUSH BUTTON STATION, LOCAL MOTOR STARTERS)															
ATTRIBUTES / CHARACTERISTICS 	ITEMS/ COMPONENTS/ SUB SYSTEM ASSEMBLIY 	Make, Model, Type, Rating & TC	Dimensions & Finish	Electrical properties	Mechanical Properties	Chemical properties	Functional & Operational Features as per THDC Spec.	Item to conform to relevant Standards	Pretreatment as per IS 6005	Paint Shade, Adhesion, Thickness & Finish	Functional Checks	Milli-volt drop Test	IR – HV – IR Test	Degree of Protection Routine test as per THDC spec	All Routine tests as per THDC spec. & relevant std.
Sheet Steel (IS : 513)	Y	Y		Y	Y		Y								
Aluminum Bus bar Material (IS : 5082)	Y	Y	Y	Y	Y		Y								
Copper Bus bar Material (IS : 613)	Y	Y	Y	Y	Y		Y								
Support Insulator	Y	Y	Y	Y			Y								
Air Circuit Breaker (IS: 13947)	Y	Y				Y	Y			Y	Y				Y
Energy Meters (IS : 13010, 13779)	Y	Y				Y	Y			Y					Y
Power & Aux. Contactors (IS : 13947)	Y	Y				Y	Y			Y					
Protection & Aux. Relays	Y	Y				Y	Y			Y					Y
Control & Selector Switches (IS : 13947)	Y	Y				Y	Y			Y					
CT's & PT's (IS 2705 / 3156)	Y	Y					Y								Y
MCCB (IS : 13947)	Y	Y					Y			Y					
Indicating Meters (IS : 1248)	Y	Y				Y	Y			Y					Y
Indicating Lamps (IS : 13947)	Y	Y				Y	Y			Y					
Air Break Switches (IS : 13947)	Y	Y				Y	Y			Y					
Control Terminal Blocks	Y	Y				Y	Y								

LT SWITCHGEAR

(Pg 2 of 2)

(MCC, PCC, ACDB, DCDB, FUSE BOARDS, LOCAL PUSH BUTTON STATION, LOCAL MOTOR STARTERS)

ATTRIBUTES / CHARACTERISTICS ITEMS/ COMPONENTS/ SUB SYSTEM ASSEMBLY 	Make, Model, Type, Rating & TC	Dimensions & Finish	Electrical properties	Mechanical Properties	Chemical properties	Functional & Operational Features as per THDC Spec.	Item to conform to relevant Standards	Pretreatment as per IS 6005	Paint Shade, Adhesion, Thickness & Finish	Functional Checks	Milli-volt drop Test	IR – HV – IR Test	Degree of Protection Routine test as per THDC spec	All Routine tests as per THDC spec. & relevant std.
Fuse (IS 13703)	Y	Y				Y	Y							
Control Transformer (IS : 12021)	Y	Y				Y	Y			Y				Y
Push Buttons (IS : 4794)	Y	Y				Y	Y			Y				
Transducer (IEC : 60688)	Y	Y				Y	Y			Y				Y
MCB (IS : 8828)	Y	Y				Y	Y			Y				
Breaker Handling Trolley	Y	Y				Y			Y	Y				Y
Synthetic Rubber Gasket (IS : 11149)	Y	Y		Y	Y		Y							
LT SWITCHGEAR (IS : 8623)	Y	Y				Y	Y	Y	Y	Y	Y	Y	Y	Y

Notes:

1. This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.
2. Makes of all major Bought Out Items will be subject to THDC approval.

E8. L.T POWER CABLES (1.1 KV PVC & XLPE) (Pg. 1 of 3)

Attributes / Characteristics	Item / Components / Sub System Assembly	Make, Rating, Type & TC	Dimension/surface finish	Mechanical Properties	Chemical Composition	Electrical Properties	Spark Test	Hot set test (XLPE)	Lay length / Sequence	Armour coverage, Cross over, looseness, Gap between two armour wire/strip	Sequential marking/surface finish /cable length	Tensile strength, elongation before & after ageing of insulation & outer sheath	Thermal Stability of insulation and outer sheath *	Anti termite treatment on wooden drums	Constructional / requirement as per THDC Spec.	Routine and acceptance test as per Relevant Standard and THDC specification	FRLS Test
Aluminum (IS-8130)		Y	Y	Y	Y	Y											
PVC Compound (IS-5831)		Y		Y		Y						Y					
XLPE Compound (IS-7098 Part-I)		Y		Y		Y		Y				Y					
FRLS PVC Compound (IS-5831) ASTM-D-2843/ ASTM-D-2863 IEC-754 Part-I		Y		Y								Y					
Armour wire/strip (IS-3975)		Y	Y	Y													
Insulated Core			Y				Y	Y					Y				
Laid up core			Y						Y								
PVC Inner sheath			Y														
Armouring			Y							Y							
Outer sheath			Y								Y	Y	Y				Y
Finish cable (IS-1554 & 7098 – Part-1) ASTM-D-2843/ IS 10810 (Part- - 58) IEC-754 Part-I Swedish Chimney SS 4241475 for (F3 category) Flammability test IEC-332 Part –3 Cat-B		Y	Y							Y	Y	Y	Y		Y	Y	Y
Wooden drum (IS-10418) / Steel drum			Y											Y			

Note:

- This is an indicative list of tests / checks. The manufacturer is to furnish a detailed quality plan indicating the Practice and procedure along with relevant supporting documents during QP finalization for all the items.***
- All major Bought Out Items will be subject to Owner's approval.**
- Any other tests mentioned in the equipment specification are also to be carried out.**
- The codes and standards mentioned in equipment specification is governing.**

<u>ROUTINE TESTS :</u>		
Routine tests shall be carried out on each drum of finished cables for all types & sizes.		
Following shall constitute routine tests:		
	Conductor Resistance test	
	High voltage test at room temperature	
ACCEPTANCE TESTS:		
	Following Acceptance tests shall be carried out for each type and size of the cables on the cable drums selected at random as per sampling plan mentioned in IS: 1554 Part 1 & IS 7098 Part-I	
A)	For Conductor	
1)	Annealing test	For copper conductor only
2)	Tensile test	For aluminium conductor only
3)	Wrapping test	For aluminium conductor only
4)	Resistance test	
B)	For Armour Wires / Formed Wires (If applicable)	
1)	Measurement of Dimensions	
2)	Tensile Tests	
3)	Elongation Test	
4)	Torsion Test	For Round wires only
5)	Wrapping Test	
6)	Resistance Test	
7)	Mass of Zinc coating test	For G S wires / Formed wires only
8)	Uniformity of Zinc coating	For G S wires / Formed wires only
9)	Adhesion test	For G S wires / Formed wires only
Freedom from defects		

E8. L.T POWER CABLES (1.1 KV PVC & XLPE) CONTD.		(Pg. 3 of 3)
C)	For PVC / XLPE insulation & PVC Sheath	
1)	Test for thickness	
2)	Hot set test	For XLPE insulation only
3)	Tensile strength & Elongation before ageing	
D)	For completed cables	
1)	Insulation resistance test (Volume resistivity method)	
2)	High voltage test at room temperature	
E)	Following tests shall be carried out and only one sample shall be taken from each offered lot of all sizes for these tests:-	
1)	Tensile strength & elongation after ageing on PVC / XLPE insulation and PVC outer sheath	
2)	Thermal stability test on PVC insulation and outer sheath	
3)	Oxygen index test on outer sheath	
4)	Smoke density rating test on outer sheath as per ASTM –D 2843	
5)	Acid gas generation test on outer sheath as per IEC – 754 (Part 1)	
6)	Flammability test as per IEC-332 - Part- 3 (Category- B) on completed cable	
7)	Fire resistance test as per SS 4241475 (F3 Category) on completed cable	
F)	Following tests shall be carried on one length of each size of offered lot:	
1)	Surface finish, length measurement, sequence of cores, armour coverage, Gap between two consecutive armour wires / formed wires	

E9. L.T CONTROL CABLES (1.1 KV PVC)

(Pg. 1 of 3)

Attributes / Characteristics	Item / Components / Sub System Assembly	Make, Type, Rating, T.C	Dimension/surface finish	Mechanical Properties	Chemical Composition	Electrical Properties	Spark Test	Lay length/Sequence	Armour coverage, cross over, looseness, gap between two armour wire	Sequential marking/surface finish/cable length	Tensile strength, elongation before & after ageing of insulation & outer sheath sheath	Thermal stability of insulation and outer sheath	Anti termite treatment on wooden drums	Constructional feature as per THDC Spec.	Routine & Acceptance test as per relevant standard & page 2 & 3 of this table	FRLS Test
Copper Conductor (IS-8130)		Y	Y	Y	Y	Y										
PVC Compound (IS-5831)		Y		Y		Y					Y					
FRLS PVC Compound IS-5831ASTM-D-2843/ IS 10810 (Part-58) IEC-754 Part-1		Y		Y							Y					Y
Armour wire/strip (IS-3975)		Y	Y	Y												
Insulated Core			Y				Y	Y				Y				
Laid up core			Y					Y								
PVC Inner sheath			Y													
Armouring			Y						Y							
Outer sheath			Y							Y	Y	Y				Y
Finish cable (IS-1554- 1) ASTM-D-2843/ IS 10810 (Part-58) IEC-754 Part-1 Swedish Chimney: SEN SS 424-1475 (F3 category) Flammability test IEC-332 Part-3 Cat-B		Y	Y						Y	Y	Y	Y		Y	Y	Y
Wooden drum (IS : 10418) / Steel drum			Y										Y			

Note:

- This is an indicative list of tests / checks. The manufacturer is to furnish a detailed quality plan indicating the Practice and procedure along with relevant supporting documents during QP finalization for all the items.***
- All major Bought Out Items will be subject to Owner's approval.**
- Any other tests mentioned in the equipment specification are also to be carried out.**
- The codes and standards mentioned in equipment specification is governing.**

ROUTINE TESTS

Routine tests shall be carried out on each drum of finished cables for all types & sizes.

Following shall constitute routine tests:

Conductor Resistance test

High voltage test at room temperature

ACCEPTANCE TESTS

Following Acceptance tests shall be carried out for each type and size of the cables on the cable drums selected at random as per sampling plan mentioned in IS: 1554 Part 1

A) For Conductor

1. Annealing test For copper conductor only
2. Resistance test

B) For Armour Wires / Formed Wires (If applicable)

1. Measurement of Dimensions
2. Tensile Tests
3. Elongation Test
4. Torsion Test For Round wires only
5. Wrapping Test
6. Resistance Test
7. Mass of Zinc coating test For G S wires / Formed wires only
8. Uniformity of Zinc coating For G S wires / Formed wires only
9. Adhesion test For G S wires / Formed wires only
10. Freedom from defects

C) For PVC insulation & PVC Sheath

1. Test for thickness
2. Tensile strength & Elongation before ageing

D) For completed cables

1. Insulation resistance test (Volume resistivity method)
2. High voltage test **at room temperature**

E) Following tests shall be carried out and only one sample shall be taken from each offered lot of all sizes for these tests:-

1. Tensile strength & elongation after ageing **on PVC insulation and PVC outer sheath**
2. Thermal stability test **on PVC insulation and outer sheath**
3. Oxygen index test **on outer sheath**
4. Smoke density rating test **on outer sheath as per ASTM –D 2843**
5. Acid gas generation test **on outer sheath as per IEC – 754 (Part 1)**
6. Flammability test as per IEC-332 - Part- 3 (Category- B) **on completed cable**
7. Fire resistance test as per SS 4241475 (F3 Category) **on completed cable**

F) Following tests shall be carried on one length of each size of offered lot:

- 1) Surface finish, length measurement, sequence of cores, armour coverage, Gap between two consecutive armour wires / formed wires

CABLING, EARTHING, LIGHTNING PROTECTION															
ATTRIBUTES / CHARACTERISTICS	ITEMS/COMPONENTS / SUB SYSTEMS	Dimension	Paint shade, paint thickness, adhesion	Pre-treatment of sheet	IP protection	Proof load*	Surface finish	Deflection test*	HV & IR	Galvanize Test (If Applicable)	Functional	Bought out items/Bill of material	Routine tests as per relevant standard & specification	Acceptance tests as per relevant standard & specification	Constructional feature as per THDC Specification
	Wall Mounted-Lighting Panel (IS-513, IS:5, IS:2629, 2633, 6745)	Y	Y	Y	Y		Y		Y	Y	Y	Y	Y	Y	Y
	Switch box/junction box/ Receptacles Panel (IS-513, IS:5, IS:2629, 2633, 6745)	Y	Y	Y	Y		Y		Y	Y	Y	Y	Y	Y	Y
	Cable glands(BS-6121)	Y											Y		
	Cable lug(IS-8309)	Y											Y		
	Lighting wire(IS-694)	Y											Y		
	Flexible conduits	Y											Y		Y
	Conduits(Galvanise & Epoxy) IS-9537 & IS-2629,2633 ,6745	Y		Y								Y	Y		Y
	RCC Hume Pipe (IS-458)												Y		
	Cable termination & straight through joint (VDE-0278)	Y											Y		Y
	Cable Trays, Flexible supports system & accessories IS-513, 2629,2633,6745	Y		Y		Y	Y	Y	Y	Y	Y		Y	Y	Y
	Trefoil clamp	Y													Y
	GI flats for earthing & lighting protection (IS 2062, 2629, 6745,2633)	Y		Y						Y			Y		Y
	GI wire (IS-280)	Y											Y		
	Fire Sealing System (BS –476)												Y	Y	Y
Note:1.This is an indicative list of tests /checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents. 2.* Deflection Test on cable trays and Proof Load test on cable trays support system will be as per details given in the THDC technical specification & approved MQP. The above acceptance tests shall be done only on one sample from each size of offered lot. 3. Make of all items will be subject to OWNER’s approval.) 4. Any other tests mentioned else where in technical specification are also to be carried out. The codes and standards mentioned in Technical specification is governing															

**ELECTRICAL EQUIPMENT SPECIFICATION
FOR
HVAC**

4 x 111 MW THDCIL VISHNUGAD HEP

SPECIFICATION NO.

VOLUME NO. : **II-B**

SECTION :

REV NO. : **00** DATE : 06.06.15

SHEET : 1 OF 1

**TECHNICAL SPECIFICATION
FOR
HVAC
(DATASHEET-A)**

	TITLE LV MOTORS <u>DATA SHEET-A</u>	SPECIFICATION NO.	
		VOLUME	II B
		SECTION	D
		REV NO. : 00 DATE : 02.01.2020	
		SHEET 1 OF 1	

1.0	Design ambient temperature	:	50 °C
2.0	Maximum acceptable kW rating of LV motor :	:	≤200KW
3.0	Installation (Indoors/ Outdoors)	:	As required
4.0	Degree Of Protection (Indoor/Outdoor)	:	IP54/IP55
5.0	Type of Cooling	:	TEFC/CACA/TETV
6.0	Details of supply system		
	a) Rated voltage (with variation)	:	415V ± 10%
	b) Rated frequency (with variation)	:	50 Hz (Variation: +3% TO –5%)
	c) Combined voltage & freq. variation	:	10%
	d) System fault level at rated voltage	:	45 kA for 1 sec
	e) Short time rating for terminal boxes	:	
	o 110kW & Above (Breaker controlled)	:	45 kA for 1 sec
	o Below 110kW (SFU+ Contactor controlled)	:	45 KA for 0.20 sec.
	f) LV System grounding	:	Solidly
7.0	Class of insulation	:	Class 'F', with temp rise limited to class B. (Refer clause 5.00.00 of Motors)
8.0	Minimum voltage for starting (As percentage of rated voltage)	:	85% of rated voltage
9.0	Power cables data	:	Shall be given during Detailed engg.
10.0	Earth Conductor Size & Material	:	Shall be given during Detailed engg.
11.0	Space heater supply	:	240 V, 1Φ , 50 Hz
12.0	Rating up to which Single phase motor	:	Acceptable below 0.20 kW
13.0	Tests	:	As per Customer motor spec. (enclosed)
14.0	Energy efficient/ Flame proof motor	:	As per Customer spec. requirement

- Also detail Customer spec. for Motors to be referred as enclosed with spec.

	DOCUMENT TITLE:	SPECIFICATION NO.
	DATA SHEET-A	VOLUME NO.
	LV SWITCHGEAR	SECTION :
		REV NO. : 00 DATE:
		SHEET : 1 OF 27

(I) LOW VOLTAGE SWITCHGEAR

(A) SWITCHGEAR

1.0 SYSTEM DESIGN DATA

1.1	Design Ambient	:	50°C
1.2	Relative Humidity		
	a) Average	:	%
	b) Maximum	:	%
1.3	Max. system voltage for continuous operations	:	457 Volt
1.4	One minute power frequency withstand voltage:		
	a) Main circuit	:	2.5 KV rms.
	b) Aux. circuit	:	2.0 KV rms.
1.5	<i>DC System fault level (220 V)</i>	:	20 KA
1.6	Formula for calculating Full Load Current (FLC)	:	kW x 1000
--	of motors		----- $\sqrt{3} \times V(\text{line}) \times \text{PF} \times \text{Efficiency}$

2.0	APPLICABLE STANDARDS	:	Latest revision of Applicable Standard
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3.0 CONSTRUCTIONAL FEATURES

3.1 GENERAL

3.1.1	Operational Fronts	:	☐ Double Front ☐ Single Front ☒ Both as per BOM
3.1.2	a. Type of sheet steel	:	☐ Hot rolled ☒ Cold rolled
	b. Sheet metal thickness (Minimum)		
	a) Non-load bearing covers	:	1.6 mm
	b) Non-load bearing partitions	:	1.6 mm
	c) Load bearing members	:	2.0 mm

	DOCUMENT TITLE:		SPECIFICATION NO.
	DATA SHEET-A LV SWITCHGEAR		VOLUME NO.
			SECTION :
			REV NO. : 00 DATE:
			SHEET : 2 OF 27
d) Frames : 2.0 mm e) Door : 1.6 mm f) Withdrawable unit : 1.6 mm 3.1.3 Rating above which louvers are permitted : 1600 Amp. 3.1.4 Degree of Protection of switchboards with modules in service and all doors closed. a) Without louvers : IP-54 b) With louvers : IP-42 3.1.5 Spare Modules : ☒ As per BOM (Load list) ☐ % 3.2 DRAWOUT MODULES 3.2.1 Type of execution of modules (functional unit) : a) Circuit breaker unit (Incoming & outgoing) : ☒ Withdrawable ☐ Fixed b) MCCB unit (Incoming) : ☒ Withdrawable ☐ Fixed c) Switch-Fuse & Contactor (Incoming) : ☒ Withdrawable ☐ Fixed d) Switch or Switch-Fuse (Incoming) : ☒ Withdrawable ☐ Fixed e) MCCB unit (Outgoing) : ☒ Withdrawable ☐ Fixed f) Contactor starter unit (Outgoing) : ☒ Withdrawable ☐ Fixed g) Switch-Fuse unit (Outgoing) : ☒ Withdrawable ☐ Fixed h) Incoming Voltage Transformer (VT) : ☒ Withdrawable ☐ Fixed i) BUS VT : ☒ Withdrawable ☐ Fixed j) Control Transformer (upto 2.5kVA) : ☐ Withdrawable ☒ Fixed k) Space Heater : ☐ Withdrawable ☒ Fixed l) Alarm : ☐ Withdrawable ☒ Fixed m) DC Supply : ☐ Withdrawable ☒ Fixed 3.2.2 Rating upto which withdrawable units : 630 Amp.			

	DOCUMENT TITLE:		SPECIFICATION NO.	
	DATA SHEET-A LV SWITCHGEAR		VOLUME NO.	
			SECTION :	
			REV NO. : 00 DATE:	
			SHEET : 3 OF 27	
applicable, if specified in 3.2.1 b), d), e) and g) above. 3.2.3 Facility for functional testing of withdrawable modules required for : a) Incomer units (PCC) : ☒ YES ☐ NO b) Incomer units (MCC) : ☒ YES ☐ NO c) Outgoing contactor starters : ☒ YES ☐ NO d) Bus - Couplers : ☒ YES ☐ NO 3.3 BUSBARS & CONNECTIONS 3.3.1 Busbar material a) Phase & Neutral : ☐ Copper ☒ Aluminium b) Earth : ☐ Copper ☐ Aluminium ☒ Galvanised MS 3.3.2 Fault Level : 50 kA 3.3.3 Short time current a) for switchboards fed by ACB / MCCB : 50 KA ,1 sec. b) For switchboards fed thru HRC Fuses : 50 KA ,0.2 sec. 3.3.4 Temperature Rise (for Horizontal Busbar) a) Design ambient : ☐ 45 ☒ 50 °C b) Temp. rise for i. Silver plated joints : ☐ 60 ☒ 55 °C ii. Non-silver plated joints : ☐ 45 ☒ 40 °C 3.3.5 Whether HRPVC sleeving to be provided for horizontal busbar : ☒ YES ☐ NO 3.3.6 Whether Shrouds on busbar tap offs to be provided : ☒ YES ☐ NO 3.3.7 Applicable method of colour coding for black PVC sleeving : Bands as per Table 1 of IS:11353				

	DOCUMENT TITLE:	SPECIFICATION NO.	
	DATA SHEET-A	VOLUME NO.	
	LV SWITCHGEAR	SECTION :	
		REV NO. : 00 DATE:	
		SHEET : 4 OF 27	

3.3.8 Busbar clearances in air (minimum)

a)	Phase-Phase	:	25 mm
b)	Phase-Earth	:	25 mm

3.4 SECONDARY WIRING

3.4.1 Colour code of wires : As per clause 3.4.3 of Sec D.

3.4.2 Sizes of wires (minimum)

a)	CT leads	:	2.5 mm ²
b)	Other wires	:	1.5 mm ²

3.5 AUXILIARY BUSES

Provision of following :

a)	AC Control Bus	:	☐ 240 V ☒ 110 V
b)	DC Control Bus	:	☒ 220 V ☐ 110 V
c)	24V AC Wdg. htg. Bus	:	☐ YES ☒ NO
d)	240V AC Space htg. Bus/buswire	:	☒ YES ☐ NO
e)	Alarm Bus/buswire	:	☐ YES ☒ NO

3.6 CONTROLS, INDICATIONS & ALARMS

3.6.1 Means for simulation testing to be provided : ☐ YES ☒ NO

3.6.2 Scope of interposing relays for remote command :
☐ Mounting & wiring only
☒ Supply, mounting & wiring interface

3.7 CABLING AND TERMINATIONS

a)	Cable Entry	:	☒ BOTTOM ☐ TOP ☐ REAR
b)	Cable Sizes (tentative)	:	As per enclosed Annexure II
c)	Type of Incoming connections from transformer to PCC (Note : Also refer BOM for respective boards.)	:	☐ Bus Trunking ☐ Cable ☒ Bus Duct

3.8 EARTHING

Size of earth bus : ☐ 300 mm² Copper(50 mm x 6mm)

	DOCUMENT TITLE:		SPECIFICATION NO.	
	DATA SHEET-A LV SWITCHGEAR		VOLUME NO.	
			SECTION :	
			REV NO. : 00 DATE:	
			SHEET : 5 OF 27	
☒ 500 mm² Galvanised MS (90 mm x 9.5 mm) : ☐ 500 mm² Aluminium Alloy as per grade 19000 H2(50 mm x 9.5 mm)				
4.0 SWITCHGEAR MAIN ASSEMBLIES				
4.1 AIR CIRCUIT BREAKERS				
4.1.1	Rated voltage	:	415 Volts	
4.1.2	Rated frequency	:	50 Hz	
4.1.3	Number of Poles	:	☒ Three ☐ Four	
4.1.4	Symmetrical (RMS) Interrupting capacity at rated voltage.	:	50 KA.	
4.1.5	Momentary making current	:	105 KA (peak)	
4.1.6	Short circuit performance category	:	P-2	
4.1.7	Short time rating			
	a) Current	:	50 KA	
	b) Duration	:	1 sec.	
4.1.8	Normal (continuous) current rating at specified design ambient (Amperes)	:	As specified in board-wise BOM / SLD	
4.1.9	One minute power frequency withstand voltage (RMS)	:	2.5 KV.	
4.1.10	Operating mechanism			
	a) Closing	:	☒ Motor wound spring ☐ Manual	
	b) Tripping	:	☐ Direct acting on incoming to MCC & outgoing circuit on PCCs to MCCs ☐ Shunt trip ☒ Both of above	
4.1.11	Operation counter required	:	☒ YES ☐ NO	
4.1.12	Auxiliary voltage			
	a) Spring charging motor	:	☒ 220 V DC ☐ 240 V AC	

	DOCUMENT TITLE:		SPECIFICATION NO.
	DATA SHEET-A LV SWITCHGEAR		VOLUME NO.
			SECTION :
			REV NO. : 00 DATE:

b) Closing release coil	:	[√] 220 V DC [] 240 V AC
c) Shunt trip coil	:	[√] 220 V DC [] 240 V AC
4.1.13 No. of Auxiliary Contacts required (min.) for indicating breaker 'ON/OFF' status and for purchaser's use	:	6 NO + 6 NC
4.1.14 Type of release (where applicable)	:	[√] Static [] Electromagnetic
4.1.15 Whether Programmable Secondary isolating contact required	:	[√] YES [] NO
4.2 CONTACTOR STARTER UNITS (DIRECT-ON-LINE)		
4.2.1 Max. motor rating upto which contactor starter can be applied.	:	BELOW 160 KW
4.2.2 Type of short circuit device	:	[√] HRC Fuse [] MCCB
4.2.3 Locked rotor protection required	:	[] YES [√] NO
4.2.4 Type of co-ordination between SCPD & other starter components as per IS:8544.	:	TYPE II
4.3 SWITCH-FUSE UNITS		
4.3.1 Breaking capacity	:	3 times rated current
with conditions :		
a) Voltage	:	110 % rated voltage
b) Power Factor	:	0.3
4.4 MOULDED CASE CIRCUIT BREAKERS (MCCB)		
4.4.1 Application		
a) Contactor Starter	:	[] YES [√] NO
b) Other circuits	:	[] YES [√] NO
c) If Yes for b) Required for rating upto	:	Amp.

	DOCUMENT TITLE:		SPECIFICATION NO.	
	DATA SHEET-A LV SWITCHGEAR		VOLUME NO.	
			SECTION :	
			REV NO. : 00 DATE:	
			SHEET : 7 OF 27	
4.4.2 Rated voltage : 415 V				
4.4.3 Number of poles : Three				
4.4.4 Rated short circuit duty : P-2				
4.4.5 Rated breaking capacity (rms) at 415 V : kA				
4.4.6 Rated making current (peak) : kA				
4.4.7 On/Off operation				
a) Manual : ☐ YES ☐ NO				
b) Remote power operated : ☐ YES ☐ NO				
4.4.8 Releases required.				
a) Overload : ☐ YES ☐ NO				
b) Under voltage : ☐ YES ☐ NO				
c) Short circuit : ☐ YES ☐ NO				
d) Shunt trip : ☐ YES ☐ NO				
4.4.9 Auxiliary contacts				
a) Numbers : 1 NO + 1 NC				
b) Rating : Amp				
5.0 SWITCHGEAR COMPONENTS				
5.1 ISOLATING SWITCH				
5.1.1 No. of poles : 3				
5.1.2 Utilization category for main contacts : AC 23(For Motor Feeder) AC 22(For Other Feeders) DC22(For DC)				
5.1.3 Auxiliary contacts				
a) Number : 1 NO + 1 NC				
b) Rating : As per Requirements				
5.1.4 Minimum thermal rating : 16 Amp.				
5.2 POWER CONTACTORS				
5.2.1 Coil voltage (nominal) : [√] 110 V AC 50 Hz				

	DOCUMENT TITLE:		SPECIFICATION NO.	
	DATA SHEET-A LV SWITCHGEAR		VOLUME NO.	
			SECTION :	
			REV NO. : 00 DATE:	
			SHEET : 8 OF 27	
☐ 240 V AC 50 Hz ☐ 110 V DC ☐ 220 V DC				
5.2.2	No. of poles for main contactor	:	Three	
5.2.3	Permissible supply voltage variation w.r.t. nominal coil voltage	:	85 – 110 %	
5.2.4	Minimum thermal rating when used in power circuit	:	16 Amp.	
5.2.5	Utilization category			
	I) AC			
	a) Reversible motor	:	AC 4(class-III)	
	b) Non-reversible motor	:	AC 3(class-III)	
	II) DC	:	DC2(class-I)	
5.2.6	Type of hold-in mechanism	:	☒ Electrically held ☐ Mechanical latch-in	
5.3	HIGH RUPTURING CAPACITY (HRC) FUSES			
5.3.1	Max. prospective fault current to be interrupted			
	a) For main circuit	:	50 KA	
	b) For Secondary circuit:			
	i. AC	:	50 KA	
	ii. DC	:	20 KA	
5.4	THERMAL OVERLOAD RELAY			
5.4.1	Range	:	80-120%	
5.4.2	Number of Contacts	:	1 NO + 1 NC	
5.4.3	Resetting	:	☒ Hand ☐ Self	
5.4.4	Single phasing prevention feature provided	:	☒ YES ☐ NO	
5.5	SINGLE PHASING PREVENTER (SPP)			
5.5.1	Separate SPP required	:	☐ YES ☒ NO	
	If yes, applicable above motor	:	kW	

	DOCUMENT TITLE:		SPECIFICATION NO.																																																						
	DATA SHEET-A LV SWITCHGEAR		VOLUME NO.																																																						
			SECTION :																																																						
			REV NO. : 00 DATE:																																																						
			SHEET : 9 OF 27																																																						
rating 5.5.2 Delay time : Variable upto 10 sec. 5.5.3 Number of Contacts : 1 NO + 1 NC 5.5.4 Resetting : [] Hand [] Self 5.6 INSTRUMENTS AND METERS 5.6.1 Indicating Instruments <table border="0"> <tr> <td>a) Function</td> <td>:</td> <td>VOLTMETER</td> <td>AMMETER</td> </tr> <tr> <td>b) Type</td> <td>:</td> <td colspan="2">Moving Iron Spring Controlled/Tau's Band</td> </tr> <tr> <td>c) Shape</td> <td>:</td> <td>Square</td> <td>Square</td> </tr> <tr> <td>d) size</td> <td>:</td> <td>96x96 mm</td> <td>96x96 mm</td> </tr> <tr> <td>e) Accuracy class</td> <td>:</td> <td>2.0</td> <td>2.0</td> </tr> <tr> <td>f) Current coil rating</td> <td>:</td> <td></td> <td>1 Amps.</td> </tr> <tr> <td>g) Voltage coil rating</td> <td>:</td> <td>110 Volts</td> <td></td> </tr> <tr> <td>h) Angle of deflection</td> <td>:</td> <td>90</td> <td>90 deg.</td> </tr> </table> 5.6.2 Energy Meters <table border="0"> <tr> <td>a) Type</td> <td>:</td> <td></td> </tr> <tr> <td>b) Accuracy class</td> <td>:</td> <td>0.5</td> </tr> <tr> <td>c) Hours of operation</td> <td>:</td> <td></td> </tr> <tr> <td>d) Current coil rating</td> <td>:</td> <td>Amps.</td> </tr> <tr> <td>e) Voltage coil rating</td> <td>:</td> <td>Volts</td> </tr> </table> 5.6.3 Provision of ammeter for motor rating : 30 KW and above 5.7 RELAYS 5.7.1 Type : [√] Static [] Electromagnetic [] Numerical 5.7.2 Coil Rating : <table border="0"> <tr> <td>a) Current coil</td> <td>:</td> <td>[√] 1 Amp. [] 5 Amp.</td> </tr> <tr> <td>b) Voltage</td> <td>:</td> <td>110 V AC/220 V DC</td> </tr> </table> 5.7.3 Means for in-built : [√] YES [] NO					a) Function	:	VOLTMETER	AMMETER	b) Type	:	Moving Iron Spring Controlled/Tau's Band		c) Shape	:	Square	Square	d) size	:	96x96 mm	96x96 mm	e) Accuracy class	:	2.0	2.0	f) Current coil rating	:		1 Amps.	g) Voltage coil rating	:	110 Volts		h) Angle of deflection	:	90	90 deg.	a) Type	:		b) Accuracy class	:	0.5	c) Hours of operation	:		d) Current coil rating	:	Amps.	e) Voltage coil rating	:	Volts	a) Current coil	:	[√] 1 Amp. [] 5 Amp.	b) Voltage	:	110 V AC/220 V DC
a) Function	:	VOLTMETER	AMMETER																																																						
b) Type	:	Moving Iron Spring Controlled/Tau's Band																																																							
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	DOCUMENT TITLE:		SPECIFICATION NO.
	DATA SHEET-A		VOLUME NO.
	LV SWITCHGEAR		SECTION :
			REV NO. : 00 DATE:
			SHEET : 10 OF 27

testing required

5.7.4 Relaying Requirement

a)	Inverse time over current	:	[] YES	[√] NO
b)	Definite time over current	:	[√] YES	[] NO
c)	Motor protection	:	[√] YES	[] NO
d)	Inverse time earth fault	:	[] YES	[√] NO
e)	Definite time earth fault	:	[√] YES	[] NO

NOTE : Refer BOM for application of relays in various types of incomers and feeders.

5.8 CURRENT TRANSFORMERS (AS PER IS: 2705)

5.8.1	Type	:	CAST RESIN	
5.8.2	Secondary Rating	:	[√] 1 Amp.	[] 5 Amp.
5.8.3	Output	:	VA (As per Requirements)	
5.8.4	Accuracy class (metering)	:	cl 2.0	
5.8.5	Accuracy class (protection)	:	5P20	
5.8.6	Accuracy limit factor (ALF)	:	20	
5.8.7	Primary current rating	:	(As per BOM) Amps.	
5.8.8	Instrument security factor	:	Not More Than 5	
5.8.9	Specific data for CTs required for differential Protection	:		
a)	Lead resistance	:		
b)	VA burden (of remote device)	:		
5.8.10	Short time rating	:	50 KA, 1sec.	
5.8.11	Dynamic Current	:	105 KA	

5.9 VOLTAGE, CONTROL & WINDING HEATING TRANSFORMERS

5.9.1 Voltage Transformers

a)	Type	:	EPOXY RESIN	
b)	System Earthing	:	[√] Effective	[] Non-effective

	DOCUMENT TITLE:		SPECIFICATION NO.	
	DATA SHEET-A LV SWITCHGEAR		VOLUME NO.	
			SECTION :	
			REV NO. : 00 DATE:	
			SHEET : 11 OF 27	
c) Secondary terminal voltage (phase-phase) : 110 Volt d) Accuracy class : 1.0 e) Output : As per requirement f) Winding configuration : g) Over voltage factor : 1.2(continuous) 5.9.2 Control Transformers (for contactor operation) a) Rated Primary voltage (Phase-Phase) : 415 volts b) Taps : ±5% in steps of 2.5% c) Minimum secondary terminal voltage (when primary voltage is minimum & transient current is maximum) : Not less than minimum pick up voltage of AC contactor d) Secondary terminal voltage : ☒ 110 V ☐ 240 V AC e) Whether separate control transformer required for individual circuit : ☐ YES ☒ NO 5.9.3 24 V Winding Heating Transformer (If required as per item 5.14 below) a) Secondary terminal voltage : 24 Volts b) Primary voltage : 415 Volts 5.10 MINIATURE CIRCUIT BREAKER 5.10.1 Application (Whether acceptable in lieu of fuses for secondary circuits) If yes, : ☒ YES ☐ NO 5.10.2 Rating : 16 Amp. 5.10.3 Short time rating : 9 KA 5.10.4 Thermal overload and magnetic short circuit protection required : YES				

	DOCUMENT TITLE:	SPECIFICATION NO.
	DATA SHEET-A	VOLUME NO.
	LV SWITCHGEAR	SECTION :
		REV NO. : 00 DATE:
		SHEET : 12 OF 27

5.11 CONTROL AND SELECTOR SWITCH

5.11.1 Application : As per schemes

5.11.2 Type

a) Control Switch : ☒ Stay put
☐ Spring return
☐ Wing knob
☐ Pistol grip

b) Selector switch : ☒ Stay put
☐ Wing knob

5.11.3 Contact rating

a) at 230V AC continuous : Amp.

b) at 220V DC breaking : Amp.

5.11.4 Contact development (give reference) :

5.11.5 Lockability

a) Control Selector switch : ☒ in each position
☐ with integral barrel lock & key

b) Control switch : ☒ In each position
☐ With integral barrel lock & key in neutral position

5.12 INDICATION LAMPS

5.12.1 Lens colour

a) On : Red

b) Off : Green

c) Auto trip : Amber

d) Service : Blue

e) Test : White

f) Spring Charged : Amber

g) Lockout relay healthy : White

h) Phases : Red, Yellow, Blue

5.12.2 Circuit voltage : ☐ 240 V AC
☒ 110 V DC

	DOCUMENT TITLE:	SPECIFICATION NO.		
	DATA SHEET-A	VOLUME NO.		
	LV SWITCHGEAR	SECTION :		
		REV NO. : 00 DATE:		
		SHEET : 13 OF 27		

[√] 220 V DC

5.13 PUSH BUTTONS

5.13.1 Voltage Grade : 415 Volt

5.13.2 No. of Contacts :

a) NO : 2
 b) NC : 2

5.13.3 Contact rating

a) At 230V AC continuous : Amp.
 b) At 220V DC breaking : Amp.

5.13.4 Function : START STOP RESET

a) Colour of actuator : Green Red Black
 b) Type of actuator head : S M S
 (S=Shrouded, M=Mushroom)
 c) Lockability : N Y N
 (Y=Yes, N=No)
 d) Any other feature : Refer Section-C of Vol. IIB

5.14 ANTI-CONDENSATION HEATERS

5.14.1 24 V motor winding heating

a) Requirement : [] YES [] NO
 If yes,

b) Applicable Rating : 30 KW
 (including & below)
 c) Maximum space heating : 40 % of FLC
 current drawn

5.14.2 Panel space heating

a) Voltage : 240 V AC
 b) Thermostat required : [√] YES [] NO
 c) If b) is yes, limit : oC
 of adjustability of

	DOCUMENT TITLE:		SPECIFICATION NO.	
	DATA SHEET-A LV SWITCHGEAR		VOLUME NO.	
			SECTION :	
			REV NO. : 00 DATE:	
			SHEET : 14 OF 27	
temp. within panel d) If b) is no, the min temp. to be maintained : °C e) Separate space heater required for front and rear panels : ☒ YES ☐ NO 5.15 GENERAL PURPOSE TIMERS (Other than electromechanical or Electronic timers used on protection scheme) 5.15.1 Type : ☒ Electronic ☐ Static 5.15.2 No. of contacts a) ON time delay : (2NO + 2NC) b) OFF time delay : (2NO + 2NC) c) Instantaneous : (1NO + 1NC) 5.15.3 Coil voltage rating (AC) : ☐ 240 V ☒ 110 V 6.0 PAINTING 6.1 Shade a) Interior : RAL 7032 b) Exterior : RAL 7032 6.2 Paint Finish a) Interior : ☐ Matt ☒ Semi-glossy b) Exterior : ☒ Semi-glossy ☐ Full-glossy 6.3 Paint thickness (i) Spray Painting : 80 microns (ii) Powder coating : 50 microns 7.0 O&M SPARES 7.1 Duration for which O&M spares required : 3 years				



DOCUMENT TITLE:

DATA SHEET-A
LV SWITCHGEAR

SPECIFICATION NO.
VOLUME NO.
SECTION :
REV NO. : **00** DATE:
SHEET : 15 OF 27

ANNEXTURE – I

Equipment, accessories, components, materials and tests shall conform, in general, to the specifications of latest revision of applicable standards.



DOCUMENT TITLE:

DATA SHEET-A
LV SWITCHGEAR

SPECIFICATION NO.
VOLUME NO.
SECTION :
REV NO. : **00** DATE:
SHEET : 16 OF 27

ANNEXURE III
MOTOR RATINGS & DATA

MOTOR RATING (kW)	POWER FACTOR	EFFICIENCY	FLC (AMP)
1.1	0.75	0.73	2.79
2.2	0.79	0.79	4.9
3.7	0.79	0.84	7.75
5.5	0.79	0.84	11.53



DOCUMENT TITLE:
**DATA SHEET-A
LV SWITCHGEAR**

SPECIFICATION NO.

VOLUME NO.

SECTION :

REV NO. : **00** DATE:

SHEET : 17 OF 27

7.5	0.8	0.87	14.99
9.3	0.8	0.88	18.37
11.0	0.8	0.89	21.49
15.0	0.83	0.89	28.24
18.5	0.85	0.89	34.02
22.0	0.85	0.9	40.0
30.0	0.85	0.9	54.55
37.0	0.86	0.91	65.77
45.0	0.86	0.92	79.19
55.0	0.85	0.92	97.84
75.0	0.84	0.93	133.56
90.0	0.84	0.93	160.27
110.0	0.84	0.93	195.89
125.0	0.84	0.93	222.6
160.0	0.84	0.93	284.93

ANNEXURE IV

LIST OF E & C SPARES

S.No.	ITEM / COMPONENT	UNIT	QUANTITY
1.0	FACTORY BUILT ASSEMBLIES (PCC / MCC / DB)		
1.1	Busbar supports (horizontal)	One (1) set of 3	
1.2	Primary isolating contacts (Bus side)	One (1) set of 3	
1.3	Primary isolating contacts (Load side)	One (1) set of 3	

	DOCUMENT TITLE:		SPECIFICATION NO.
	DATA SHEET-A LV SWITCHGEAR		VOLUME NO.
			SECTION :
			REV NO. : 00 DATE:
			SHEET : 18 OF 27
1.4	Secondary isolating contacts	One (1) set of 3	
1.5	Gaskets (each size)	One (1) set	
1.6	Resistor (each size)	Twelve (12)	
1.7	Fixed Terminal Block (control)	One (1) way	
1.8	Shrouds (ACB O/G terminals)	One (1) set	
1.9	Wire (for secondary wiring)		
	a) 2.5 mm ²	metres	
	b) 1.5 mm ²	metres	
1.10	Lugs (for secondary wiring)	Twelve (12)	
1.11	Ferrules Set*		
2.0	AIR CIRCUIT BREAKER		
2.1	Shunt trip coil	One (1)	
2.2	Spring charging motor	One (1)	
2.3	Closing release coil	One (1)	
2.4	Auxiliary switch	One (1)	
2.5	Solid state trip devices (or spares thereof)	One (1) set	
Set comprises of all alphabets 100 Nos. each and numerals (0-9) 100 Nos. each.			
S.No.	ITEM / COMPONENT	UNIT	QUANTITY
3.0	ISOLATING SWITCH (FOR EACH RATINGS)		
3.1	Complete unit (each rating)	One (1)	
3.2	Main contact kit	One (1) set of 3	
3.3	Arc Chamber	One (1)	
4.0	POWER CONTACTORS		
4.1	Complete unit (each rating)	One (1)	
4.2	Contact coil (each size)	One (1)	
4.3	Contacts kit (main)	One (1) set of 3	



DOCUMENT TITLE:

**DATA SHEET-A
LV SWITCHGEAR**

SPECIFICATION NO.

VOLUME NO.

SECTION :

REV NO. : 00 DATE:

SHEET : 19 OF 27

4.4 Contacts kit (auxiliary) Set of standard number
of pairs

5.0 AUXILIARY CONTACTORS

5.1 Complete unit One (1)

5.2 Contactor coil One (1)

6.0 HRC FUSE

6.1 Fuse base (each rating) One (1)

6.2 Fuse link (each rating) Two (2)

7.0 PUSH BUTTONS

7.1 Actuator contacts One (1)

7.2 Element One (1) set

8.0 INDICATING LAMPS

8.1 Complete unit One (1)

8.2 Lens (assorted) One (1)

9.0 OTHERS

9.1 Selector & control switch
(each type) One (1)

9.2 Control transformer
(each rating) One (1)

9.3 MCB One (1) of each ating



DOCUMENT TITLE:

DATA SHEET-A
LV SWITCHGEAR

SPECIFICATION NO.
VOLUME NO.
SECTION :
REV NO. : **00** DATE:
SHEET : 20 OF 27

ANNEXURE- VII

LIST OF APPROVED SUBVENDORS

Vendor shall select the make of components of the switchgear from the list below. However, names of the sub-vendors may be added or deleted from the list without any intimation to the vendor and therefore it is mandatory on the part of the vendor to take approval on the make of components.

- | | | |
|------------------------|---|--|
| 1. Air Circuit Breaker | : | Control & Switchgear
L&T
Siemens
GE-power |
| 2. MCCB (AC) | : | L&T
Crompton Greaves
GE-power
Siemens |
| 3. MCCB (DC) | : | Crompton Greaves |

	DOCUMENT TITLE:		SPECIFICATION NO.
	DATA SHEET-A LV SWITCHGEAR		VOLUME NO.
			SECTION :
			REV NO. : 00 DATE:
			SHEET : 21 OF 27
			L&T GE-power Siemens
4. Isolating Switch	:	L&T	Siemens Alstom Ltd. Control & Switchgear GE-power Kaycee
5. AC Contactor	:	L&T	Siemens Telemecanique BCH GE-power
6. DC Contactor	:		BHEL (BHOPAL) Electromac Industries L&T Siemens Telemecanique GE-power
7. FUSE Base			GE-power L&T
8. FUSES			Indo-Asian
9. HRC Fuse (Base & Link)	:	L&T	Siemens GE power Control & Switchgear
10. Single Phasing Preventer	:	L&T	
11. Voltmeter	:		Automatic Electric IMP Rishabh Industrial
12. Ammeter	:		Automatic Electric IMP Rishabh Industrial
13. Energy Meter	:		BHEL (EDN) SIMCO Engg.
14. Relays (other than interposing relays)	:		ABB Alsthom(Areva)
Interposing relays	:		Jyoti
15. Current transformer	:		Automatic Electric Indcoil

	DOCUMENT TITLE:		SPECIFICATION NO.
	DATA SHEET-A LV SWITCHGEAR		VOLUME NO.
			SECTION :
			REV NO. : 00 DATE:
			SHEET : 22 OF 27
			Kappa Electricals Pragati Electricals Precise Electricals PROYOG Silkaans Southern Electriks Control & Switchgear Siemens
16. Voltage Transformers (VT)	:	:(Same as current Trfrs except C & S and Siemens)	
17. Control Transformers	:	Automatic Electric Indcoil Kappa Electricals Precise Electricals Silkaans Southern Electriks Logicstat	
18. Winding heating trfr	:	(Same as current Trfrs)	
19. Miniature Circuit Breaker	:	MDS Switchgear INDO ASIAN S & S Power Switchgear	
20. Control switch	:	Kaycee Alstom GE-Power	
21. Selector switch	:	Kaycee Alstom	
22. Indicating Lamp	:	Control & switchgear Alstom Essen Siemens Concord BCH GE-Power	
23. Panel space heater	:	Control & Switchgear	
24. General Purpose Timer	:	BCH L & T Alstom Electronic Automation Telemecanique	
25. Push Button	:	BCH Control & Switchgear Cands L&T	

	DOCUMENT TITLE:		SPECIFICATION NO.
	DATA SHEET-A LV SWITCHGEAR		VOLUME NO.
			SECTION :
			REV NO. : 00 DATE:
			SHEET : 23 OF 27
			Siemens Tecknic Controls Hotline Switchgears
26. Breaker Operation Counter	:	Kaycee	
27. Breaker switch	:	Kaycee L & T	
28. Neutral Link	:	L&T Siemens	
29. Cable Gland	:	Arup Engg. & Foundry Works Commet Brass Products Electrmac Industries Allied Traders & Exporters Baliga Lighting Eqpt. Elexpro Electricals Incab Sunil & Co.	
30. Cable Lugs	:	Dowells Universal Machines	
31. DC Switch	:	Kaycee Siemens GE-Power	
32. Fixed terminals	:	Control & Switchgear Connect well Elemex Technoplast	
33. Lighting Switch	:	Anchor Ellora	
34. Limit switch	:	Concord Siemens	
35. Sockets	:	Anchor Crompton Greaves	
36. Terminal drawout	:	Control & Switchgear L&T Alstom Siemens	
37. Thermostat	:	Automatic Instrumentation	



DOCUMENT TITLE:

DATA SHEET-A
LV SWITCHGEAR

SPECIFICATION NO.
VOLUME NO.
SECTION :
REV NO. : **00** DATE:
SHEET : 24 OF 27

B) LOCAL PUSHBUTTON STATION AND LOCAL STARTER

(TICK AS APPROPRIATE)

1. Requirement : ☐ Local starter
: ☐ Local Push Button Station
: ☒ Both

2.0 TECHNICAL PARTICULARS FOR LOCAL STARTER

- 2.1 Voltage rating (V) : 415 V
& frequency (Hz) : 50 Hz
Fault level (KA) : 50 KA
2.2 **Motor rating(s) (KW)** : **REFER BOM**
2.3 Enclosure sheet

	DOCUMENT TITLE:		SPECIFICATION NO.
	DATA SHEET-A LV SWITCHGEAR		VOLUME NO.
			SECTION :
			REV NO. : 00 DATE:
			SHEET : 25 OF 27
	Steel thickness (mm)	:	2 mm
2.4	Degree of protection of enclosure	:	IP-54 for indoor IP-55 for outdoor
2.5	Cable entry	:	Top/Bottom
2.8	COMPONENT RATINGS		[As per requirements]
2.8.1	Contactor	:	
2.8.1.1	Category of duty	:	AC3
2.8.1.2	Coil voltage (V)	:	110 V AC
2.8.1.3	Short time rating	:	50 KA
2.8.4	Power cable size	:	-----LATER-----
3.0	LOCAL PUSH BUTTON STATION		
3.1	Push button station type	:	Refer BOM
3.2	Stop push button type (cl.4.7.1 section-D, vol. IIB)	:	As per sec-C, vol. IIB
3.3	Push button station	:	Sheet steel/Die cast aluminium
3.4	Thickness of enclosure	:	2 mm for sheet steel 3 mm for die cast aluminium
3.5	Aluminium alloy (for enclosure) grade	:	-----as per IS-----
3.7	Degree of protection of enclosure	:	IP-55 for outdoor IP-54 for indoor
3.8	Control cable size & Number of cores	:	-----LATER-----
3.9	Cable entry	:	Top/Bottom
4.0	COMMON REQUIREMENTS FOR LOCAL CONTROL STATIONS		
4.1	Design Ambient (°C)	:	50° C
4.2	Environment	:	[√] Tropical [] Marine [] Hazardous
4.3	Designation List	:	---- LATER--
4.4	PAINTING		
4.4.1	Paint finish shade	:	

	DOCUMENT TITLE:		SPECIFICATION NO.
	DATA SHEET-A LV SWITCHGEAR		VOLUME NO.
			SECTION :
			REV NO. : 00 DATE:
			SHEET : 26 OF 27
Exterior	:	RAL7032	
Interior	:	RAL7032	
4.4.2 Paint thickness	:	50-60 microns	
4.5 COMPONENT RATING			
4.5.1 Push button	:		
4.5.1.1 Type	:		
4.5.1.2 Breaking current rating (A) at voltage (V)	:	____A at ____V	
4.5.1.3 Function	:		
4.5.1.4 Actuator colour	:		
4.5.1.5 No. of contacts	:	2NO+2NC	
4.5.1.6 Colour			
Start P.B.	:	Green	
Stop P.B.	:	Red	
4.5.2 CONTROL & SELECTOR SWITCH		N.A	
4.5.2.1 Current rating (A)			
4.5.2.2 Make & carry current (A)	:		
4.5.2.3 Break current at voltage (V)	:		
4.5.2.4 Make and type	:		
4.5.2.5 Number of contacts	:		
4.5.3 INDICATION LAMPS			
4.5.3.1 Function & lens colour	:	ON—RED OFF--- GREEN	
4.5.3.2 Working voltage (V)	:	240 V	
4.5.4 AMMETERS		N.A	
4.5.4.1 Type	:		
4.5.4.2 Size (mm x mm)	:		
4.5.4.3 Burden for remote ammeter (if any)	:		
4.5.4.4 CT secondary rating (A)	:		



DOCUMENT TITLE:

DATA SHEET-A
LV SWITCHGEAR

SPECIFICATION NO.
VOLUME NO.
SECTION :
REV NO. : **00** DATE:
SHEET : 27 OF 27

- 4.5.4.5 Number of terminals for
External connection & spare :
- 4.6 Earth conductor size (Sq.mm/SWG) :



DOCUMENT TITLE

TECHNICAL SPECIFICATION FOR 1.1 kV
PVC POWER CABLES

SPECIFICATION NO.

VOLUME

SECTION

REVISION 1

DATE:

SHEET 1 OF 4

DATA SHEET-A

DS-AI. SPECIFIC TECHNICAL REQUIREMENTS

1.0	Type of Cable	Flame Retardant Low Smoke (FRLS)	
2.0	Standard applicable in general	IS: 1554 PART (I)	
3.0	Voltage Grade	1.1kV	
4.0	Number of cores, cross sectional area of conductors and quantities	As per BOQ, Annexure-A to Section-C	
5.0	Formula for calculating short circuit current for different durations	$I_{sh} = k A / \sqrt{t}$ where, I_{sh} = Short circuit current in kA t = Fault clearing time in sec. K = a constant = 0.069 for Aluminium conductor HRPVC insulation = 0.104 for copper conductor HRPVC insulation = 0.076 for Aluminium conductor PVC insulation = 0.115 for copper conductor PVC insulation	
6.0	Installation Conditions for specified current rating		
(a)	ambient air temperature	40 deg. C	
(b)	ground temperature	30 deg. C	
(c)	depth of laying of cables buried in ground	75 cm	
(d)	Thermal resistivity of soil	150 deg. C cm/W	
7.0	CONDUCTOR		
(a)	Material	Aluminium	Copper
	Grade and Class	Stranded, H2, Class 2	Stranded, Un-tinned (plain) annealed high conductivity, Class 2
(b)	Standard Applicable	IS: 8130	
(c)	Shape	Circular / shaped as per IS	
(d)	Min. number of strands	As per Table-2 of IS: 8130	
8.0	INSULATION		
(a)	Material	PVC type-A/C	
(b)	Standard Applicable	IS: 1554 Part-I	
(c)	Continuous withstand temperature	70°C/ 85 °C	
(d)	Short-circuit withstand temperature	160°C	
(e)	Method of application	By extrusion; sleeve extrusion not permitted.	
9.0	CORE IDENTIFICATION	Colour coding as per IS.	
10.0	INNER SHEATH (applicable for multi core		



DOCUMENT TITLE

TECHNICAL SPECIFICATION FOR 1.1 kV
PVC POWER CABLES

SPECIFICATION NO.

VOLUME

SECTION

REVISION 1

DATE:

SHEET 2 OF 4

	cables only)	
(a)	Material	PVC Type <i>ST1/ ST2</i> as per IS: 5831
(b)	Colour	<i>Black</i>
(c)	Whether FRLS	<i>No</i>
(d)	Fillers	Acceptable
(e)	Material of fillers (if permitted)	Same as inner sheath (Material of filler to be compatible with that of inner sheath)
(f)	Method of application	
(1)	Multi-core cables:	
(i)	With fillers	<i>Pressure/Vacuum extruded</i>
(ii)	Without fillers	<i>Pressure extruded</i>
11.0	ARMOUR (where applicable)	
(a)	Material:	
(i)	Single core cables	Aluminium Round Wire H4 grade to IS: 8130
(ii)	Multi-core cables	Galvanised Steel <i>Round Wire / Formed wire</i> armour conforming to (i) Type 'a/' 'b' as per Table- 5 of IS 1554-I and (ii) IS 3975 as per project requirements.
(b)	Minimum Coverage	90%
(c)	Gap between armour wires	Shall not exceed one armour wire space (No cross-over/ over-riding)
(d)	Breaking load of joint	95 % of normal armour
12.0	OUTERSHEATH	
(a)	Material	PVC Type <i>ST1/ ST2</i> as per IS: 5831
(b)	Colour	<i>Black</i>
(c)	Whether FRLS	Yes
(d)	Method of application	Extruded
(e)	Marking	<i>Cable size (cross section area and no. of cores) and voltage grade @ 5m (by embossing) Letters FRLS @ 5m (by embossing) Manufacturer's name and/ or trade name, and year of manufacture @ 5m (by embossing) Progressive sequential marking @ 1m. (by embossing/ printing).</i>
13.0	FRLS CHARACTERISTICS	
(a)	Oxygen index	Min 29 (As per ASTM D 2863)
(b)	Temperature index	Min. 250°C
(c)	Acid gas generation	<i>Max. 20% (as per IEC-754-1)</i>
(d)	Smoke density rating	<i>60% (As per ASTM D2843)</i>
(e)	Flammability Test	As per IEC: 60332 Part-3-23 <i>Cat-B/</i> IS-1554-I/ Swedish chimney (where applicable)
14.0	TOLERANCE ON OUTER DIAMETER	Up to 30mm; + 1.5mm Above 30mm; + 5% or + 2mm, whichever is less.
15.0	MINIMUM BENDING RADIUS	
(a)	Single core cables	15 x O.D.
(b)	Multi core cables	12 x O.D.



DOCUMENT TITLE

TECHNICAL SPECIFICATION FOR 1.1 kV
PVC POWER CABLES

SPECIFICATION NO.

VOLUME

SECTION

REVISION 1

DATE:

SHEET 3 OF 4

16.0	SAFE PULLING FORCE	
(a)	Aluminium conductor cable	30 N/ sq. mm.
(b)	Copper conductor cable	50 N/ sq. mm.
17.0	CABLE DRUMS	
(a)	Type & construction	As per IS 10418
(b)	Standard drum length	500m (±) 5% / 1000m (±) 5%. (as specified in BOQ)

DS-AII. TYPE/ ACCEPTANCE TEST REQUIREMENTS

A. Type Test Conduction:

- Tests for which an asterisk sign (*) is indicated in the 'Conduction Required as Type Test' column shall be conducted on one size of cable to be selected by purchaser at the time of testing as type tests. The same may be witnessed by BHEL/ Owner, for which due notice shall be given by the vendor.

B. Acceptance Test Conduction:

- Tests for which a hash sign (#) is indicated in the 'Conduction Required as Acceptance Test' column shall be conducted as acceptance tests.
- Sampling:
Sampling for acceptance tests shall be as per Appendix-A (Clause 15.2.1) of IS: 1554 Part-I.

S. No.	TEST	APPLICABLE FOR	CONDUCTION REQUIRED AS	
			Type Test	Acceptance Test
1.0	Tests for Conductor			
	Annealing test	Copper conductor only	*	#
	Tensile test	Aluminium conductor only	*	#
	Wrapping test	Aluminium conductor only	*	#
	Resistance test	Al/Cu	*	#
2.0	Tests for Armour Wires			
	Measurement of dimensions	Aluminium wire & GS wire	*	#
	Tensile test	Aluminium wire & GS wire		#
	Elongation test	GS wire only	*	#
	Torsion test	GS round wire only	*	#
	Resistance test	Aluminium wire & GS wire	*	#
	Zinc coating test	G. S. wires only	*	#
	Wrapping Test	Aluminium wires only	*	#
3.0	Physical Tests for PVC Insulation & PVC sheath			



DOCUMENT TITLE

TECHNICAL SPECIFICATION FOR 1.1 kV
PVC POWER CABLES

SPECIFICATION NO.

VOLUME

SECTION

REVISION 1

DATE:

SHEET 4 OF 4

S. No.	TEST	APPLICABLE FOR	CONDUCTION REQUIRED AS	
			Type Test	Acceptance Test
	Test for thickness	PVC insulation, PVC inner sheath & PVC outer sheath	*	#
	Tensile strength and elongation test	PVC insulation & PVC outer sheath	*	
	(a) Before ageing		*	#
	(b) Before & after ageing		*	
	Ageing in air oven	PVC insulation & PVC outer sheath	*	
	Loss of mass test	PVC insulation & PVC outer sheath	*	
	Hot deformation test	PVC insulation & PVC outer sheath	*	
	Heat shock test	PVC insulation & PVC outer sheath	*	
	Shrinkage test	PVC insulation & PVC outer sheath	*	
	Thermal stability test	PVC insulation & PVC outer sheath	*	
4.0	<u>FRLS/ Flammability Tests</u>			
	Oxygen index test	PVC outer sheath only	*	#
	Smoke density test	PVC outer sheath only	*	#
	Acid gas generation test	PVC outer sheath only	*	#
	Flammability test to IEC 332 Part-III, Category-B	Complete cable	*	
	Flammability test to IS: 1554 Part-I	Complete cable	*	#
	Swedish chimney test to SEN SS 424 1475	Complete cable		#
5.0	<u>Electrical Tests</u>			
	High Voltage Test (Water Immersion test)	On cores	*	
	High Voltage Test at room temperature	Complete cable	*	#
	Insulation Resistance Test (Volume resistivity method)	Complete cable	*	#

	DOCUMENT TITLE TECHNICAL SPECIFICATION FOR LT CONTROL CABLES	SPECIFICATION NO.	
		VOLUME II B	
		SECTION -D	
		REVISION 00	DATE:
		SHEET 1 OF 3	

DATASHEET A

SPECIFIC TECHNICAL REQUIREMENTS

- | | | |
|--|---|--------------------------------------|
| 1.0 Type of cable | : | FRLS |
| 2.0 Standard applicable | : | IS:1554 Part-I (in general) |
| 3.0 Voltage designation of cables | : | 1.1 kV |
| 4.0 Number of cores and cross sectional area | : | As per BOQ, Annexure-A to Section-C. |

5.0 CONDUCTOR

- | | | |
|------------------------|---|---|
| a) Material | : | Copper, plain annelaed high conductivity, class-2 |
| b) Strands | : | (Min.) 7 |
| c) Applicable standard | : | IS : 8130 |

6.0 INSULATION

- | | | |
|--|---|--|
| a) Material & Standard | : | PVC, Type A (IS:5831) |
| b) Continuous withstand temperature | : | 70° C |
| c) Short circuit withstand temperature | : | 160° C |
| d) Method of Application | : | By extrusion (sleeve extrusion not permitted) |
| e) Volume resistivity | : | As per relevant standards |

7.0 IDENTIFICATION OF CORES

- | | | |
|---------------------------------|---|--|
| a) Control cables upto 5 core | : | Colour coded as per IS : 1554 (Part-I) |
| b) Control cables above 5 cores | : | By numbering as per IS:1554 (Part-I)
Insulation to have black colour. |

	DOCUMENT TITLE TECHNICAL SPECIFICATION FOR LT CONTROL CABLES	SPECIFICATION NO.	
		VOLUME II B	
		SECTION -D	
		REVISION 00	DATE:
		SHEET 2 OF 3	

8.0 INNER SHEATH (for all armoured cables & multi-core unarmoured cables)

- | | | | |
|----|-------------------------|---|---------------------------|
| a) | Material & Standard | : | PVC Type ST 1 (IS : 5831) |
| b) | Colour | : | Black |
| c) | Whether FRLS | : | NO |
| d) | Fillers | : | Acceptable |
| e) | Material of fillers | : | Same as innersheath. |
| f) | Method of application : | | |
| | i) with fillers | : | Pressure/Vacuum Extruded |
| | ii) without fillers | : | Pressure Extruded. |

9.0 ARMOUR(WHEREVER APPLICABLE)

- | | | |
|------|-----------------------------------|--|
| (i) | Material: | |
| a) | Multicore cables | :Galvanised steel wire/formed wire conforming to IS : 3975, Min. coverage of 90% |
| b) | Single core cable (IF APPLICABLE) | :Hard drawn Aluminium conforming to IS : 8130. |
| (ii) | Breaking load of joint | : 95% of normal armour |

10.0 OUTER SHEATH

- | | | | |
|----|---------------------|---|---------------------------|
| a) | Material & Standard | : | PVC Type ST 1 (IS : 5831) |
| b) | Application | : | Extruded |
| c) | Colour | : | Black |
| d) | Whether FRLS | : | YES |

	DOCUMENT TITLE TECHNICAL SPECIFICATION FOR LT CONTROL CABLES	SPECIFICATION NO.	
		VOLUME II B	
		SECTION-D	
		REVISION 00	DATE:
		SHEET 3 OF 3	

11.0 CHARACTERISTICS OF FRLS SHEATH

- | | | | |
|----|----------------------|---|--|
| a) | Oxygen index | : | Min. 29 (As per ASTM D 2863) |
| b) | Temperature Index | : | Min. 250° C at room temperature. |
| c) | Acid gas generation | : | Max. 20% (As per IEC-754-1) |
| d) | Smoke density rating | : | Max. 60% (As per ASTM D 2843) |
| e) | Flammability Test | : | As per IEC-332-Part-III (Category-B), IEEE-383 & Swedish Chimney test as per SS:424-1475 |

12.0 TOLERANCE ON OUTER DIAMETER

- | | | | |
|----|------------------|---|-------------------------------------|
| a) | Upto 30 mm O.D. | : | (+/-) 1.5 mm |
| b) | Above 30 mm O.D. | : | (+/-) 5% or 3 mm whichever is less. |

13.0 STANDARD DRUM LENGTH : 1000 m (+/-) 5%

14.0 PROGRESSIVE SEQUENTIAL LENGTH MARKING TO BE PROVIDED ON OUTER SHEATH

: YES @ 1 metre

15.0 DRUM MARKINGS

: Manufacturer's name and/or trade name, Year of manufacture, Type of cable and the voltage class, Nominal cross sectional area of conductor and number of cores, Letter HR in case of HR PVC insulated cables, Letter FRLS Applicable in case of FRLS cables.

TABLE - 1**STANDARD CABLE PARAMETERS FOR INSTRUMENTATION CABLE**

Parameter	0.5 mm ² (I & OS) type-F	0.5 mm ² (OS) type-G
Mutual Capacitance (max.) at 0.8 kHz, nF/Km	120	100
Conductor Loop Resistance (max.), Ohm / Km	73.4	73.4
Insulation Resistance (min), M Ohm/ Km	100	100
Cross Talk attenuation (min) at 0.8kHz, dB	60	60
Characteristic impedance(max.) at 1 kHz	320	340
Attenuation (max.) at 1 kHz db/Km	1.2	1.2

Notes

1. The voltage grade of Instrumentation cable shall be 225 V (peak value).
2. Cable parameters indicated above are at 20 degC (+/- 3 deg C).



**TECHNICAL SPECIFICATION FOR
ABOVE GROUND EARTHING & LIGHTNING
PROTECTION MATERIALS**

SPECIFICATION NO. PE-TS-~~XXX~~-509-E003
VOLUME NO. : II-B
SECTION : D
REV NO. : 0 DATE :
SHEET : 1 OF 2

TECHNICAL DATASHEET-A

1.0 APPLICABLE STANDARDS:

- | | | |
|----|--|----------|
| a) | For Hot rolled carbon sheets & strips. | IS: 2062 |
| b) | For Mild Steel Wire | IS: 280 |
| c) | For Surface Pre-treatment | IS: 2629 |
| d) | For Hot dip galvanising of steel | IS: 2629 |
| e) | For Hot dipped galvanised coating on round steel wires | IS: 4826 |
| f) | For Testing of zinc coating | IS: 2633 |
| g) | For Determining of mass of zinc coating | IS: 6745 |
| h) | For Rolling & cutting tolerances of hot rolled steel products | IS: 1852 |
| i) | For Hot dip zinc coating on structural steel & other allied products | IS: 4759 |
| j) | For Tubes, Tubulars and other Wrought Steel Fittings | IS: 1239 |

2.0 GALVANIZED MS MATERIALS FOR ABOVE GROUND EARTHING AND LIGHTNING PROTECTION SYSTEMS

- | | | |
|----|-----------|-----------------------|
| a) | Material: | Hot Rolled Mild Steel |
| b) | Type: | Hot-dip galvanized |

3.0 SURFACE TREATMENT

Galvanising:

- | | | |
|----|----------------------------------|---------------------------------------|
| a) | Pre-treatment | As per IS 2629 prior to galvanization |
| b) | Type | Hot dip galvanization. |
| c) | Applicable Standard | IS 2629 |
| d) | Minimum thickness: | |
| | i) MS flats 5mm thick & over | 75 microns (minimum) |
| | ii) MS flats under 5mm thickness | 60 microns (minimum) |



**TECHNICAL SPECIFICATION FOR
ABOVE GROUND EARTHING & LIGHTNING
PROTECTION MATERIALS**

SPECIFICATION NO. PE-TS-XXX-509-E003
VOLUME NO. : II-B
SECTION : D
REV NO. : 0 DATE :
SHEET : 1 OF 2

- | | |
|--|----------------------------|
| iii) Pipes/ conduits with thickness 5 mm & over. | 75 microns (minimum) |
| iv) Pipes/ conduits with thickness under 5mm | 60 microns (minimum) |
| v) GI Wire | 20 Microns (Medium coated) |
- e) Min. weight :
- | | |
|--|---------------------|
| i) MS flats 5mm thick & over | 610 gms. / sq. mtr. |
| ii) MS flats under 5mm thickness | 460 gms. / sq. mtr. |
| iii) Pipes/ conduits with thickness 5 mm & over. | 610 gms. / sq. mtr |
| iv) Pipes/ conduits with thickness under 5mm. | 460 gms. / sq. mtr |
| v) GI Wire | 150 gms. / sq. mtr |

**ELECTRICAL EQUIPMENT SPECIFICATION
FOR
HVAC**

4 x 111 MW THDCIL VISHNUGAD HEP

SPECIFICATION NO.

VOLUME NO. : **II-B**

SECTION : **D**

REV NO. : **00** DATE : 02.01.2020

SHEET : 1 OF 1

**TECHNICAL SPECIFICATION

FOR

HVAC

(SEC-D)**

	TITLE : GENERAL TECHNICAL REQUIREMENTS FOR LV MOTORS	SPECIFICATION NO. PE-SS-999-506-E101
		VOLUME NO. : II-B
		SECTION : D
		REV NO. : 00 DATE :
		SHEET : 1 OF 4

1.0

INTENT OF SPECIFIATION

The specification covers the design, materials, constructional features, manufacture, inspection and testing at manufacturer’s work, and packing of Low voltage (LV) squirrel cage induction motors along with all accessories for driving auxiliaries in thermal power station.

Motors having a voltage rating of below 1000V are referred to as low voltage (LV) motors.

2.0

CODES AND STANDARDS

Motors shall fully comply with latest edition, including all amendments and revision, of following codes and standards:

IS:325	Three phase Induction motors
IS : 900	Code of practice for installation and maintenance of induction motors
IS: 996	Single phase small AC and universal motors
IS: 4722	Rotating Electrical machines
IS: 4691	Degree of Protection provided by enclosures for rotating electrical machines
IS: 4728	Terminal marking and direction of rotation rotating electrical machines
IS: 1231	Dimensions of three phase foot mounted induction motors
IS: 8789	Values of performance characteristics for three phase induction motors
IS: 13555	Guide for selection and application of 3-phase A.C. induction motors for different types of driven equipment
IS: 2148	Flame proof enclosures for electrical appliance
IS: 5571	Guide for selection of electrical equipment for hazardous areas
IS: 12824	Type of duty and classes of rating assigned
IS: 12802	Temperature rise measurement ofr rotating electrical machnines
IS: 12065	Permissible limits of noise level for rotating electrical machines
IS: 12075	Mechanical vibration of rotatinf electrical machines

In case of imported motors, motors as per IEC-34 shall also be acceptable.

3.0

DESIGN REQUIREMENTS

3.1

Motors and accessories shall be designed to operate satisfactorily under conditions specified in data sheet-A and Project Information, including voltage & frequency variation of supply system as defined in Data sheet-A

3.2

Motors shall be continuously rated at the design ambient temperature specified in Data Sheet-A and other site conditions specified under Project Information
Motor ratings shall have at least a 15% margin over the continuous maximum demand of the driven equipment, under entire operating range including voltage & frequency variation specified above.

3.3

Starting Requirements

3.3.1

Motor characteristics such as speed, starting torque, break away torque and starting time shall be properly co-ordinated with the requirements of driven equipment. The accelerating torque at any speed with the minimum starting voltage shall be at least 10% higher than that of the driven equipment.

3.3.2

Motors shall be capable of starting and accelerating the load with direct on line starting without exceeding acceptable winding temperature.

	TITLE : GENERAL TECHNICAL REQUIREMENTS FOR LV MOTORS	SPECIFICATION NO. PE-SS-999-506-E101
		VOLUME NO. : II-B
		SECTION : D
		REV NO. : 00 DATE :
		SHEET : 2 OF 4
The limiting value of voltage at rated frequency under which a motor will successfully start and accelerate to rated speed with load shall be taken to be a constant value as per Data Sheet - A during the starting period of motors.		
3.3.3 The following frequency of starts shall apply i) Two starts in succession with the motor being initially at a temperature not exceeding the rated load temperature. ii) Three equally spread starts in an hour the motor being initially at a temperature not exceeding the rated load operating temperature. (not to be repeated in the second successive hour) iii) Motors for coal conveyor and coal crusher application shall be suitable fro three consecutive hot starts followed by one hour interval with maximum twenty starts per day and shall be sutable for mimimum 20,000 starts during the life time of the motor		
3.4 Running Requirements		
3.4.1 Motors shall run satisfactorily at a supply voltage of 75% of rated voltage for 5 minutes with full load without injurious heating to the motor.		
3.4.2 Motor shall not stall due to voltage dip in the system causing momentary drop in voltage upto 70% of the rated voltage for duration of 2 secs.		
3.5 Stress During bus Transfer		
3.5.1 Motors shall withstand the voltage, heavy inrush transient current, mechanical and torque stress developed due to the application of 150% of the rated voltage for at least 1 sec. caused due to vector difference between the motor residual voltage and the incoming supply voltage during occasional auto bus transfer.		
3.5.2 Motor and driven equipment shafts shall be adequately sized to satisfactorily withstand transient torque under above condition.		
3.6 Maximum noise level measured at distance of 1.0 metres from the outline of motor shall not exceed the values specified in IS 12065.		
3.7 The max. vibration velocity or double amplitude of motors vibration as measured at motor bearings shall be within the limits specified in IS: 12075.		
4.0 CONSTRUCTIONAL FEATURES		
4.1 Indoor motors shall conform to degree of protection IP: 54 as per IS: 4691. Outdoor or semi-indoor motors shall conform to degree of protection IP: 55 as per IS: 4691and shall be of weather-proof construction. Outdoor motors shall be installed under a suitable canopy		
4.2 Motors upto 160KW shall have Totally Enclosed Fan Cooled (TEFC) enclosures, the method of cooling conforming to IC-0141 or IC-0151 of IS: 6362. Motors rated above 160 KW shall be Closed Air Circuit Air (CACA) cooled		
4.3 Motors shall be designed with cooling fans suitable for both directions of rotation.		

	TITLE : GENERAL TECHNICAL REQUIREMENTS FOR LV MOTORS	SPECIFICATION NO. PE-SS-999-506-E101
		VOLUME NO. : II-B
		SECTION : D
		REV NO. : 00 DATE :
		SHEET : 3 OF 4
4.4.	Motors shall not be provided with any electric or pneumatic operated external fan for cooling the motors.	
4.5	Frames shall be designed to avoid collection of moisture and all enclosures shall be provided with facility for drainage at the lowest point.	
4.6	In case Class 'F' insulation is provided for LV motors, temperature rise shall be limited to the limits applicable to Class 'B' insulation. In case of continuous operation at extreme voltage limits the temperature limits specified in table-1 of IS:325 shall not exceed by more than 10°C.	
4.7	Terminals and Terminal Boxes	
4.7.1	Terminals, terminal leads, terminal boxes, windings tails and associated equipment shall be suitable for connection to a supply system having a short circuit level, specified in the Data Sheet-A. Unless otherwise stated in Data Sheet-A, motors of rating 110 kW and above will be controlled by circuit breaker and below 110 kW by switch fuse-contactor. The terminal box of motors shall be designed for the fault current mentioned in data sheet "A".	
4.7.2	Unless otherwise specified or approved, phase terminal boxes of horizontal motors shall be positioned on the left hand side of the motor when viewed from the non-driving end.	
4.7.3	Connections shall be such that when the supply leads R, Y & B are connected to motor terminals A B & C or U, V & W respectively, motor shall rotate in an anticlockwise direction when viewed from the non-driving end. Where such motors require clockwise rotation, the supply leads R, Y, B will be connected to motor terminals A, C, B or V W & V respectively.	
4.7.4	Permanently attached diagram and instruction plate made preferably of stainless steel shall be mounted inside terminal box cover giving the connection diagram for the desired direction of rotation and reverse rotation.	
4.7.5	Motor terminals and terminal leads shall be fully insulated with no bare live parts. Adequate space shall be available inside the terminal box so that no difficulty is encountered for terminating the cable specified in Data Sheet-A.	
4.7.6	Degree of protection for terminal boxes shall be IP 55 as per IS 4691.	
4.7.7	Separate terminal boxes shall be provided for space heaters.. If this is not possible in case of LV motors, the space heater terminals shall be adequately segregated from the main terminals in the main terminal box. Detachable gland plates with double compression brass glands shall be provided in terminal boxes.	
4.7.8.	Phase terminal boxes shall be suitable for 360 degree of rotation in steps of 90 degree for LV motors.	
4.7.9	Cable glands and cable lugs as per cable sizes specified in Data Sheet-A shall be included. Cable lugs shall be of tinned Copper, crimping type.	
4.8	Two separate earthing terminals suitable for connecting G.I. or MS strip grounding conductor of size given in Data Sheet-A shall be provided on opposite sides of motor frame. Each terminal box shall have a grounding terminal.	
4.9	General	

	TITLE : GENERAL TECHNICAL REQUIREMENTS FOR LV MOTORS	SPECIFICATION NO. PE-SS-999-506-E101
		VOLUME NO. : II-B
		SECTION : D
		REV NO. : 00 DATE :
		SHEET : 4 OF 4

4.9.1 Motors provided for similar drives shall be interchangeable.

4.9.2 Suitable foundation bolts are to be supplied alongwith the motors.

4.9.3 Motors shall be provided with eye bolts, or other means to facilitate safe lifting if the weight is 20Kgs. and above.

4.9.4 Necessary fitments and accessories shall be provided on motors in accordance with the latest Indian Electricity rules 1956.

4.9.5 All motors rated above 30 kW shall be provided with space heaters to maintain the motor internal air temperature above the dew point. Unless otherwise specified, space heaters shall be suitable for a supply of 240V AC, single phase, 50 Hz.

4.9.6 Name plate with all particulars as per IS: 325 shall be provided

4.9.7 Unless otherwise specified, the colour of finish shall be grey to Shade No. 631 and 632 as per IS:5 for motors installed indoor and outdoor respectively. The paint shall be epoxy based and shall be suitable for withstanding specified site conditions.

5.0 **INSPECTION AND TESTING**

5.1 All materials, components and equipments covered under this specification shall be procured, manufactured, as per the BHEL standard quality plan No. PED-506-00-Q-006/0 and PED-506-00-Q-007/2 enclosed with this specification and which shall be complied.

5.2 LV motors of type-tested design shall be provided. Valid type test reports not more than 5 year shall be furnished. In the absence of these, type tests shall have to be conducted by manufacturer without any commercial implication to purchaser.

5.3 All motors shall be subjected to routine tests as per IS: 325 and as per BHEL standard quality plan.

5.4 Motors shall also be subjected to additional tests, if any, as mentioned in Data Sheet A.

6.0 **DRAWINGS TO BE SUBMITTED AFTER AWARD OF CONTRACT**

a) OGA drawing showing the position of terminal boxes, earthing connections etc.

b) Arrangement drawing of terminal boxes.

c) Characteristic curves:
(To be given for motor above 55 kW unless otherwise specified in Data Sheet).

i) Current vs. time at rated voltage and minimum starting voltage.

ii) Speed vs. time at rated voltage and minimum starting voltage.

iii) Torque vs. speed at rated voltage and minimum voltage.
For the motors with solid coupling the above curves i), ii), iii) to be furnished for the motors coupled with driven equipment. In case motor is coupled with mechanical equipment by fluid coupling, the above curves shall be furnished with and without coupling.

iv) Thermal withstand curve under hot and cold conditions at rated voltage and max. permissible voltage.

	TITLE GENERAL TECHNICAL REQUIREMENTS OF LV SWITCHGEAR	STD. SPECIFICATION NO.	
		VOLUME	
		SECTION D	
		REV NO. 00	DATE:
		SHEET	1 OF 37

CONTENTS

(I) LOW VOLTAGE SWITCHGEAR

(A) SWITCHGEAR

1.0 SCOPE

2.0 CODES AND STANDARDS

3.0 CONSTRUCTIONAL FEATURES

3.1 GENERAL REQUIREMENTS

3.2 DRAWOUT MODULES

3.3 BUSBARS & CONNECTIONS

3.4 SECONDARY WIRING AND TERMINALS

3.5 AUXILIARY BUSBARS

3.6 CONTROL, INDICATIONS & ALARMS

3.7 CABLE TERMINATIONS

3.8 EARTHING

3.9 LABELING

4.0 SWITCHGEAR MAIN ASSEMBLIES

4.1 AIR CIRCUIT BREAKERS

4.1.1 General Requirements

4.1.2 Operating Mechanism

4.1.3 Isolating Devices

4.1.4 Shutters

4.1.5 Contacts and Arc Shields

4.1.6 Interlocking and Locking Facilities

4.1.7 Circuit Breakers with releases

4.1.8 Operating Conditions

4.2 CONTACTOR STARTER UNITS

	TITLE GENERAL TECHNICAL REQUIREMENTS OF LV SWITCHGEAR	STD. SPECIFICATION NO.	
		VOLUME	
		SECTION D	
		REV NO. 00	DATE:
		SHEET	2 OF 37

4.3

SWITCH FUSE UNITS

4.4

MOULDED CASE CIRCUIT BREAKERS

5.0

SWITCHGEAR COMPONENTS

5.1

ISOLATING SWITCH

5.2

CONTACTORS

5.3

HIGH RUPTURING CAPACITY (HRC) FUSES

5.4

THERMAL OVERLOAD PROTECTION

5.5

SINGLE PHASING PREVENTER

5.6

INSTRUMENTS AND METERS

5.7

PROTECTIVE AND AUXILIARY RELAYS

5.8

CURRENT TRANSFORMERS

5.9

VOLTAGE, CONTROL & HEATING TRANSFORMERS

5.10

SECONDARY FUSES, LINKS & MCBs

5.11

CONTROL AND SELECTOR SWITCH

5.12

INDICATION LAMPS

5.13

PUSH BUTTONS

5.14

ANTI- CONDENSATION HEATERS

5.15

GENERAL PURPOSE TIMERS

6.0

PAINTING

7.0

PACKING

8.0

GUARANTEED PERFORMANCE REQUIREMENTS

9.0

INSPECTION & TESTS

10.0

SPARES

11.0

TOOLS & TACKLE

12.0

DOCUMENTATION

(C)

LOCAL PUSHBUTTON STATION AND LOCAL STARTER

	TITLE	STD. SPECIFICATION NO.	
	GENERAL TECHNICAL REQUIREMENTS OF LV SWITCHGEAR	VOLUME	
		SECTION D	
		REV NO. 00	DATE:
		SHEET	3 OF 37

1.0

SCOPE

2.0

CODES & STANDARDS

3.0

DESIGN REQUIREMENTS

4.0

CONSTRUCTION FEATURES

5.0

SHOP INSPECTION & TEST

6.0

PAINTING & FINISH

7.0

LIST OF ENCLOSURES

8.0

DRAWINGS/ DOCUMENTS TO BE SUBMITTED AFTER AWARD OF CONTRACT

	TITLE GENERAL TECHNICAL REQUIREMENTS OF LV SWITCHGEAR	STD. SPECIFICATION NO.	
		VOLUME	
		SECTION D	
		REV NO. 00	DATE:
		SHEET	4 OF 37

(I) LOW VOLTAGE SWITCHGEAR

(A) SWITCHGEAR

1.0 SCOPE

1.1 This specification covers the design, manufacture, assembly, testing and inspection at vendor’s/sub-vendor’s works, packing and despatch to site of low voltage switchgear as described in the various sections of this specification.

1.2 In cases where erection and commissioning is not included in vendor’s scope, the vendor shall still not be absolved of his responsibility of establishing the correctness of equipment at site.

1.3 Specific requirements given in Section-C form part of this specification and shall be fully complied with.

2.0 CODES & STANDARDS

2.1 Unless specified otherwise, the latest revision of the relevant standards and other applicable statutory rules and regulations are applicable and shall be referred to.

3.0 CONSTRUCTIONAL FEATURES

3.1 GENERAL REQUIREMENTS

3.1.1 The switchboard shall be air-insulated, metal enclosed type. The equipment offered shall be of proven design.

3.1.2 Make of all components of switchboard shall be subject to the approval of purchaser. However, a tentative list of BHEL approved make of components enclosed for reference only.

3.1.3 Switchboard shall be of modular design, consisting of units or modules, segregated into single or multi-tier compartments. Each unit shall be placed in individual compartment. All units grouped together shall form the complete switchboard. Completed switchboard shall be of flush-fronted design having a neat appearance and shall be readily extensible.

3.1.4 The switchboards shall be built up of horizontal withdrawable or fixed units as per Data Sheet A. The switchboard, besides the common units viz. busbar chambers, cable alleys etc., shall consist of following feeder units, as required:

a) Circuit breaker unit

b) Contactor starter unit

	TITLE GENERAL TECHNICAL REQUIREMENTS OF LV SWITCHGEAR	STD. SPECIFICATION NO.	
		VOLUME	
		SECTION D	
		REV NO. 00	DATE:
		SHEET	5 OF 37

c) Isolating switch - fuse unit

d) Moulded Case Circuit Breaker unit

3.1.5 Switchboards may be of single front or double-front design as per SEC-C.

3.1.6 For ease of operation, the height of operating handles and push buttons shall not be above 2000 mm or below 200 mm with respect to the finished floor level unless otherwise specifically approved by purchaser.

3.1.7 Switchboards shall be constructed from mild steel sheet and structural sections. Type of steel and thickness shall be as per Data Sheet A. The design and construction of switchboard shall ensure adequate rigidity.

3.1.8 Vertical cable chambers/alleys of 250 mm width shall be provided for incoming and outgoing cables in motor control centre sections.

3.1.9 Where two cable chambers/alleys in each motor control section are provided, each cable chamber shall have minimum 200mm width.

3.1.10 Door shall be provided at the front of each compartment to give full access to all the components and the compartment.

3.1.11 The switchboard shall consist of dust and vermin proof cubicles.

3.1.12 Good quality synthetic rubber/ neoprene gaskets shall be put around the door & cover edges for protection against dust. The door when closed, shall compress the gasket uniformly. For equipment mounted on door the mounting arrangement shall comply with the requirements of specified degree of protection.

3.1.13 Cutout edges for instruments, relays etc. shall have sufficient overlap surface to minimize the dust entry. The arrangement for the front mounting of switch handles shall render the switchboard reasonably dusts free such that the normal operations are not affected.

3.1.14 It shall be preferred to have an enclosure design without the use of louvers. However, for busbar ratings above 1600 Amperes suitable louvers backed up with fine wire mesh are permitted for natural cooling. Wire mesh on roof of panel is not acceptable. Ventilating hoods with side louvers & wire mesh will be acceptable.

3.1.15 Degree of protection for completed switchboards shall be as per SEC-C.

3.1.16 Switchboard covers (including doors without interlock) shall be bolted on type, shall be designed to give access to individual circuits without exposing other circuits, which may be live. Alternatively, circuits exposed by the removal of the cover shall be individually shrouded.

3.1.17 The switchboards shall be designed to prevent contact with live parts both within the modules and in the cable alley.

3.1.18 Following are the minimum segregations to be provided amongst the different parts of the switchboard.

	TITLE GENERAL TECHNICAL REQUIREMENTS OF LV SWITCHGEAR	STD. SPECIFICATION NO.	
		VOLUME	
		SECTION D	
		REV NO. 00	DATE:
		SHEET	6 OF 37

a)

Main horizontal busbar chamber and vertical busbar chamber.

b)

Between different modules.

c)

Between modules and cable chamber.

d)

Between auxiliary busbars and the rest of the switchboard.

e)

Between vertical busbars and modules.

3.1.19

All insulating materials used as partitions, guards, shrouds shall be non-hygroscopic & flame retardant.

3.1.20

All components mounted in the switchboard shall be accessible and shall not impede access to wiring or terminals. All faults except busbar fault, which may occur within any individual unit, shall be confined within that unit only and shall not cause shutdown of any section of the board other than the affected unit itself. Maintenance and inspection shall be possible in any individual unit without affecting other units.

3.1.21

The rated continuous current of the equipment and components shall be as given in the BOM / Load Data List / Schemes. These ratings shall be obtained with the components mounted in their housing as in service without exceeding the permissible temperature rise.

3.1.22

Interlock between compartment door and modules shall be provided such that the door cannot be opened without switching off the power supply to the module. Defeat interlock shall be provided for the units comprising of switch or moulded case circuit breaker as a means of isolation, such that it is possible to open the door with device ON and the unit in SERVICE position. The following shall apply under these conditions:

a)

It shall not be possible to close the door till the interlock has been reinstated.

b)

Attempted withdrawal of the unit under such conditions shall be cautioned against by providing Warning Label affixed at an appropriate place.

3.1.23

Switchboards shall be equipped with thermostatically controlled space heaters in each panel (separate for front and rear in case of double fronted panels having separate cable alleys).

3.1.24

Plug and socket with switch for connecting hand lamp rated 240 V AC single phase shall be provided in each shipping section (on both fronts in case of double front panels).

3.1.25

During detailed engineering, purchaser may ask for the special requirements in the switchboards to overcome the layout constraints. Following criteria shall be considered while composing the switchboards:

a)

Switchboards shall not be kept over the floor expansion joints.

b)

Panel located on the top of a cross beam with its cable chamber substantially obstructed by the beam shall have no such circuits which involve external cable connections from the bottom.

	TITLE GENERAL TECHNICAL REQUIREMENTS OF LV SWITCHGEAR	STD. SPECIFICATION NO.	
		VOLUME	
		SECTION D	
		REV NO. 00	DATE:
		SHEET	7 OF 37

c) Panel coming in front of a vertical column will not have any operating mechanism if the minimum clearance of switchboard w.r.t. the column is not available. In marginal cases approval of purchaser may be sought.

To overcome the constraints specified above, it may be desirable to include dummy panels with flexible busbars or to have the expansion panels. Bidder shall submit his proposal along with applicable unit prices for such arrangements.

3.1.26 Each switchboard shall be fitted with base frame made of angle or channel with slotted angles for field alignment with the foundation channel. The foundation channel shall also be supplied where erection & commissioning is specified to be included in vendor’s scope. The foundation channel shall have tapped holes and shall be adequately sized and braced with cross-members. All fixing nuts and bolts together with grounding bolts shall be provided.

3.1.27 Lifting lugs shall be provided on each shipping section. Removal of such lugs or hooks shall leave no opening in the switchboard.

3.1.28 Spare modules shall be provided as indicated in SEC-C.

3.2 **DRAWOUT MODULES**

3.2.1 The requirements of the withdrawable modules shall be as per SEC-C.

3.2.2 Withdrawal of units shall be possible without disconnecting wires.

3.2.3 Withdrawable units of similar type and rating shall be interchangeable.

3.2.4 The bus & circuit side power connections shall be through self-aligning and self-isolating contacts.

3.2.5 All parts of load and bus side of drawout isolating power contacts shall be easily replaceable.

3.2.6 The design of fixed and moving current carrying parts shall not permit any galvanic action between the two.

3.2.7 The drawout design shall be able to withstand the stated fault level (as limited by the associated short circuit protection device) both thermally as well as dynamically without undergoing any permanent deformation or damage. The designed capability shall be qualified by means of a test report.

3.2.8 Secondary connections to the withdrawable unit shall be through self-aligning and self-isolating contacts. In case of circuit breakers, easily disconnectible plug and socket shall be acceptable in place of self-aligning and self-isolating type contacts.

3.2.9 The isolating contacts shall have sufficient mechanical strength to withstand rough handling during insertion and withdrawal of module.

3.2.10 The secondary isolating contacts shall have continuous minimum current rating of 16 Amp. at 240 V AC or 4 Amp. at 220 V DC.

3.2.11 Withdrawable units of circuit breaker and contactor starter module shall have 3 positions, namely, SERVICE-TEST-ISOLATION.

	TITLE GENERAL TECHNICAL REQUIREMENTS OF LV SWITCHGEAR	STD. SPECIFICATION NO.	
		VOLUME	
		SECTION	D
		REV NO. 00	DATE:
		SHEET	8 OF 37

3.2.12 The units shall have facilities for functional testing of the unit where specified in SEC-C.

3.2.13 In TEST position, power supply to the module shall get disconnected automatically, while control supply remains connected for testing.

3.2.14 With the drawout module fully removed from its housing, live parts exposed shall either be finger proof or shall have means to shroud them totally to prevent contact. Suitable add-on type shrouds shall be provided where automatic shutters or inbuilt shrouds are not provided.

3.3 **BUSBARS & CONNECTIONS**

3.3.1 **Main Busbars (Horizontal)**

3.3.1.1 Each switchboard shall be provided with one set of main busbars having three phases, one neutral and one earth busbar.

3.3.1.2 Main busbars shall be arranged horizontally at the top of the switchboard with vertical tee-offs for connection to the cubicles. Neutral busbars located at the bottom are also acceptable.

3.3.1.3 Busbars shall be contained in a separate vermin-proof compartment within the switchboard and shall have bolted on sheet steel covers for providing suitable access.

3.3.1.4 Busbars and busbar connections shall not be exposed when covers and doors are opened for access to other units and chambers of the switchboard.

3.3.1.5 Busbars and supporting arrangement shall be capable of withstanding specified short circuit current and electro-dynamic forces arising during short circuit without undergoing any permanent damage or deformation to busbars or insulators. Short circuit level is specified in SEC-C.

3.3.1.6 Busbars (including neutral busbar) shall be capable of carrying the short-time current for the duration as specified in Data Sheet A, without any damage.

3.3.1.7 Phase busbars shall be designed to carry continuously the rated full load current without exceeding the specified temperature rise limit.

The maximum temperature rise of main busbars at a design ambient of 45°C shall be 45°C when carrying rated current. For other ambient conditions, temperature rise shall be as per Data Sheet A. The temperature rise of silver plated joints shall be 60°C over ambient of 45°C subject to prior approval.

3.3.1.8 Current carrying capacity of neutral busbar shall be half of the phase busbar but in no case shall the cross-sectional area be less than 150 sq.mm.

3.3.1.9 Main busbars and connections shall be prominently marked and displaced for standard sequence counting from rear to front, top to bottom, or left to right as viewed from the switching device operating mechanism side. For double front switchboards, the ‘front’ for the purpose of counting the phase sequence of busbars shall be reckoned as per the approved general arrangement drawings.

3.3.2 **Vertical Busbars & Connections**

3.3.2.1 Vertical connections from the busbars shall have a continuous current rating of not less than the sum of the continuous current rating of all the equipment connected to them.

	TITLE GENERAL TECHNICAL REQUIREMENTS OF LV SWITCHGEAR	STD. SPECIFICATION NO.	
		VOLUME	
		SECTION	D
		REV NO. 00	DATE:
		SHEET	9 OF 37

3.3.2.2 For double front type of board, separate vertical busbars for each front shall be used.

3.3.2.3 Where it is not possible to make power connections by busbar flats the same shall be made by PVC insulated stranded copper conductor having black colour outer sheath with colour code for phase identification. This connection shall be rigid and small in length. Conductor size shall not be less than 2.5 sq. mm. This is also applicable for power connection made within functional unit/modules.

3.3.2.4 The connection from busbar to isolating device/ fuses shall be made as short as possible and shrouded to minimise the possibility of a phase to phase short circuit.

3.3.3 **Common Requirements of Busbars**

3.3.3.1 Busbars shall be made of either high conductivity copper (ETC) or aluminium grade D63401WP as per SEC-C. They shall be supported on insulators of material such as fibre reinforced polyester, epoxy cast resin.

3.3.3.2 The insulation level of neutral busbar shall be same as that of phase busbars.

3.3.3.3 Each busbar shall be of uniform cross-section for its entire length.

3.3.3.4 Where specified in Data Sheet A, all busbars and bus connections shall be provided with close fitting PVC sleeve to render them dust and dirt free. All such bends which cannot be PVC sleeved, shall be taped preferably with polyester tape. The PVC sleeve shall be suitable for the maximum operating temperature encountered for busbars and connections. If the sleeve is of black colour, busbars shall be colour coded as per applicable standard and as indicated in Data Sheet A. Coloured bands at suitable intervals shall be provided to identify the phases in such cases.

3.3.3.5 Busbar Joints shall meet the following requirements:

- a) Busbar and tap off joints shall be bolted type.
- b) Busbars shall be thoroughly cleaned before jointing. Suitable contact grease shall be applied to remove oxide film just before jointing.
- c) For copper busbars, the connecting portion shall be tinned or silver-plated.
- d) All bolts and washers for joints shall be of zinc plated & passivated or cadmium plated steel. Disc. & Spring washers or Belleville washers shall be used.
- e) The joints shall be provided with removable shrouds made of glass fibre reinforced moulded plastic material or epoxy cast resin type material to provide accessibility of joint bolts for maintenance.

3.4 **SECONDARY WIRING AND TERMINALS**

3.4.1 All internal wiring for connections to remote equipment shall run to terminal boards. Spare auxiliary switches, contacts or relay contacts shall also be wired upto terminal board as per schemes. Wires shall not be jointed or teed-off between terminal points.

3.4.2 Wiring shall be made by 1100-volt grade seven strands PVC insulated copper wire having a cross-sectional area of not less than 1.5 sq.mm. All connections from CT leads upto instruments, relays, terminal board shall be made by copper wires of minimum 2.5 sq.mm. size. The cables shall be tested for flammability test as per applicable standards and shall also withstand service temperature without deterioration.

	TITLE GENERAL TECHNICAL REQUIREMENTS OF LV SWITCHGEAR	STD. SPECIFICATION NO.	
		VOLUME	
		SECTION D	
		REV NO. 00	DATE:
		SHEET	10 OF 37

3.4.3 All wiring shall be made with the Colour Codes specified below:

a)	3 phase AC Connections	Phase 1 (R)	Red
		Phase 2 (Y)	Yellow
		Phase 3 (B)	Blue
b)	1 phase AC Connections	Phase	Red
		Neutral	Black
c)	DC Connections	Positive	Red
		Negative	Blue
		Neutral	Black
d)	Earth Connection	-	Green

NOTE:

1.

Colour of outer sheath of AC and DC wiring shall be grey. However for DC control wiring, white colour of outer sheath is also acceptable.

2.

Where the single-phase conductors are associated with the 3-phase system from which they are derived, the phase conductor shall use the same colour as that phase from which it is derived.

3.4.4 Where wiring is subjected to movement, flexible wires having not less than 40 strands, with a minimum cross-sectional area of 2.5 sq. mm. of conductors, shall be used.

3.4.5 Wiring shall be run mostly clear of all metal parts in insulated cleats & shall be properly routed, neatly bunched. However, PVC wire holders and channels shall be preferred for running of wiring.

3.4.6 Where wiring passes from one compartment to another, the aperture shall be ‘Bushed’ to prevent damage of wires against sheet metal edges. Bushes may comprise of good quality rubber grommets.

3.4.7 Intermodule bus wires shall be kept separate from all other wiring. AC or DC terminations shall be grouped function-wise as far as possible and labels of the function shall be affixed.

3.4.8 Every wire end for interpanel termination shall be fitted with numbered ferrules of white or yellow colour having glossy finish with identification number engraved in black. Ferrules shall be made of moisture and oil resisting insulating material. Ferrules shall be of interlocked type or tight fitting type. Ferrules shall be so fitted that they will not get detached, when the wire is removed from the terminal.

3.4.9 System of marking of wiring shall be as per applicable standard.

3.4.10 All wires used internally shall have crimped on tinned copper lugs for terminations.

3.4.11 Terminal boards shall be either of stud or pressure screw or insertion type. Insulating barriers of adequate height shall be provided between adjacent pairs of terminals unless the terminal board moulding inherently provides a barrier between pair of terminals. Transparent front covers shall be provided if the terminals are not finger proof. Terminals shall have marking for terminal identification.

	TITLE GENERAL TECHNICAL REQUIREMENTS OF LV SWITCHGEAR	STD. SPECIFICATION NO.	
		VOLUME	
		SECTION	D
		REV NO. 00	DATE:
		SHEET	11 OF 37

3.4.12 Terminal boards shall have separate terminals for incoming and outgoing wires with not more than two wires connected to any one terminal.

3.4.13 Terminal boards shall be mounted vertically at the side of the cubicle or in the horizontal rows and properly spaced to have clean wiring arrangement, adequate access for putting ferrules, making terminations etc. It shall be possible to read the ferrule numbers when the wiring is complete. Where terminals may be live when the equipment is isolated from the main supply, these shall be clearly marked on the panel.

3.4.14 Spare terminals to the extent of twenty percent of the used terminals shall be provided for each module.

3.5 **AUXILIARY BUSBARS**

3.5.1 The auxiliary busbars/buswire of copper of adequate size shall be provided as per requirements specified in Data Sheet A.

3.5.2 The auxiliary busbar connections shall be continuously sleeved with PVC insulation and supported at regular interval.

3.6 **CONTROL, INDICATIONS & ALARMS**

3.6.1 The controls, indications and alarms shall be provided as per enclosed schemes.

3.6.2 The location of control for switchgear shall be either the control room, local to the equipment controlled, on the switchgear or in any combination of these as per typical schemes enclosed with Section-C. Control-Selector-Switch shall be provided accordingly.

3.6.3 All switchgear comprising of withdrawable units shall have test feature, where specified in Data Sheet A, for operation check-up purposes. This will allow manual and/or electrical closing and tripping of switchgear with power connection disconnected both at the bus and circuit ends. In the TEST position, all incoming & outgoing remote electrical controls and interlocks shall not cause the switchgear equipment to be operated manually or otherwise.

3.6.4 Means for simulation testing shall be provided, where called for in SEC-C.

3.6.5 Circuit breaker control switches shall be operated in clockwise direction for closing the circuit breaker and anti-clockwise for opening (tripping) and shall automatically return to the neutral (mid-position).

3.6.6 The alarm bell in alarm circuits shall be suitable for the duty imposed on it by the ringing cycle as per scheme.

3.7 **CABLE TERMINATIONS**

3.7.1 All cables, either incoming or outgoing to the switchboard, shall be terminated in a cable chamber. For each cubicle, there shall be a cable chamber on the side or on the rear. The door of cable chamber should open or be locked with the help of a tool. Unless stated otherwise in Data Sheet A, all cables shall enter from the bottom.

3.7.2 Removable undrilled gland plates shall be provided in the cable chamber at the bottom for sealing the entry of cables. For single core cables, aluminium plates shall be fitted. Minimum thickness of

	TITLE GENERAL TECHNICAL REQUIREMENTS OF LV SWITCHGEAR	STD. SPECIFICATION NO.	
		VOLUME	
		SECTION	D
		REV NO. 00	DATE:
		SHEET	12 OF 37

gland plate shall be 4 mm for aluminium plate and 3mm for sheet steel plate. The gland plate shall be of adequate size for accommodating requisite number of cable glands for power and control cables.

3.7.3 Heavy-duty bolt-on termination tinned copper lugs of compression type shall be used in the switchgear for power cable termination.

3.7.4 For supporting and clamping of cable cores at regular interval in cable alleys, suitable slotted angle upto the respective terminal blocks shall be provided.

3.7.5 The supply of tinned copper cable lugs for power cables forms part the supply of equipment.

3.7.6 Where two circuit breakers are provided in one panel having common cable chamber, horizontal barriers of insulating material shall be provided between cable connections of two breakers, so that while accessing a circuit, the personnel are not exposed to the other circuit which may be live. Termination for power cables shall be fully shrouded to avoid accidental touch with live cable termination.

3.8 **EARTHING**

3.8.1 An earth busbar having a minimum cross-sectional area of 300 sq. mm copper or 500 sq. mm. galvanised MS or Aluminium alloy shall be provided at the bottom for the entire length of the switchboard.

3.8.2 Every metal part other than those forming parts of an electrical circuit shall be connected to the earth bus by means of high conductivity copper wire.

3.8.3 The cores of transformer (bus potential transformer, control transformer, 24 winding heating transformer etc.) shall also be earthed through copper wire.

3.8.4 Metallic cases of instruments, relays, switches and other associated components mounted in the switchboard shall be connected to the earth busbar by copper conductors of not less than 2.5 sq. mm. cross-sectional area.

3.8.5 The metal parts of withdrawable units shall positively & independently get earthed before the primary connections are made. Scraping earth contact shall be fitted on withdrawable equipment and shall be designed to ensure positive earthing. Mere sheet steel contacts between two parts shall not be considered as earthing bondage.

3.8.6 The earthing of circuit breaker shall be achieved through a robust spring loaded, tinned copper contact of sliding type. One side of the contact shall be connected to the main earth busbar.

3.8.7 Doors shall have a copper wire for earth connection to fixed unit.

3.8.8 Arrangement shall be provided for connecting the internal earth bar to the external earthing station.

3.9 **LABELING**

	TITLE GENERAL TECHNICAL REQUIREMENTS OF LV SWITCHGEAR	STD. SPECIFICATION NO.	
		VOLUME	
		SECTION D	
		REV NO. 00	DATE:
		SHEET	13 OF 37

3.9.1 Labels to identify all the Main assemblies, Sub-assemblies and components of the switchboard shall be provided. Rating of the items identified shall also be indicated.

3.9.2 Name and rating plate/ marking shall be provided as required by relevant standard applicable to each component/ assembly to be identified.

3.9.3 Labels shall be of two colour, three layer plastic material with matt or semi matt finish or have anodized aluminium.

3.9.4 All labels other than “Danger” or “Warning” labels shall have white lettering on a black background. Danger labels shall have letters on Red Background and shall not be affixed on to removable parts.

3.9.5 All labels shall be securely fixed on to the equipment by means of self tapping screws or other approved means.

3.9.6 Stick on type labels of good quality and permanent mounting shall be acceptable for internally mounted components only.

3.9.7 A list of all such items to be labelled and text and type of labels to be provided is given below:

a) BOARD DESIGNATION (MAIN EQUIPMENT LABEL)

i. Inscription: Voltage, Designation & Code.

ii. Location: Top centre in the front of the switchboard; on both sides for double front switchboards.

iii. Material: 3 Layer, 3mm thick plastic material, or 2mm thick anodise Aluminium fixation by self-tapping, on-rusting screws, white inscription on black background.

b) MODULE - FEEDER DESIGNATION

i. Inscription: Load/Service Designation, Module Type, Rating and Module Code.

ii. Location: Both inside and outside the module; also rear of the ACB panel. At least one of the labels on fixed portion.

iii. Material: White engraving on black anodised aluminium plate of thickness 2mm. Plate to be secured with screws/plastic rivets.

c) COMPONENT DESIGNATION

i. Inscription: Letter Symbol as assigned in Schemes, Rating for control fuses.

ii. Location: Near or on the component

iii. Material: Stick on type

	TITLE GENERAL TECHNICAL REQUIREMENTS OF LV SWITCHGEAR	STD. SPECIFICATION NO.	
		VOLUME	
		SECTION	D
		REV NO. 00	DATE:
		SHEET	14 OF 37

4.0

SWITCHGEAR MAIN ASSEMBLIES

4.1

AIR CIRCUIT BREAKERS

4.1.1

General Requirements

4.1.1.1

Circuit breaker units shall be of air-break, metal enclosed horizontal withdrawable type having short circuit ratings specified in Data Sheet A.

4.1.1.2

Moving portion of each circuit breaker unit shall consist of 3 or 4 poles, as specified in Data Sheet A, with common operating mechanism, primary and secondary disconnecting (isolating) devices, auxiliary switches, mechanical position indicator and necessary wiring all mounted on a robust steel frame work.

4.1.1.3

Primary and secondary disconnecting devices shall be robust, reliable, fully self-isolating and self-aligning. These shall comprise of silver plated copper contacts. It is preferred to have a design with the secondary disconnecting devices located on the side of the circuit breaker.

4.1.1.4

All the secondary disconnecting devices shall make both in SERVICE & TEST position of the circuit breakers, unless specified for programmable type functions and called for in SEC-C.

4.1.1.5

Secondary disconnecting device comprising of single multiway plug & socket is also acceptable provided the interlocking requirements as specified in clause 4.1.6 are fulfilled.

4.1.1.6

Circuit breakers of same current rating shall be fully inter changeable with one another. The design shall prevent circuit breakers from being taken into TEST and SERVICE positions of fixed housing of breakers of different ratings. The arrangement shall be such as to prevent damage to isolating contacts.

4.1.1.7

Positively driven auxiliary switches shall be provided for indication, control & interlocking. These shall comprise of a minimum 6NO + 6NC contacts in addition to those required for internal use. These shall be wired upto the secondary isolating devices. Where the specified number of auxiliary contacts is not available, the same shall be derived through suitable contact multiplication.

4.1.1.8

It shall be possible to draw in or out the breaker to SERVICE, TEST & ISOLATED position without opening the cubicle door. It shall be possible to close the door even when circuit breaker is drawn out to ISOLATED or TEST position, thus preventing entry of vermin & dust.

4.1.1.9

It shall be possible to manually charge the closing spring and close/trip the breaker without opening door. Access to the device affecting these shall be possible even with compartment door closed.

4.1.1.10

The circuit breaker shall be provided with the following set of positively driven mechanical position indicators available on the door front.

a)

Breaker ON/OFF

b)

Breaker SERVICE/TEST/ISOLATED

c)

Breaker closing spring CHARGED/DISCHARGED

The mechanism shall be such that failure of auxiliary spring shall not prevent tripping and also not cause tripping of closed circuit breaker.

	TITLE GENERAL TECHNICAL REQUIREMENTS OF LV SWITCHGEAR	STD. SPECIFICATION NO.	
		VOLUME	
		SECTION D	
		REV NO. 00	DATE:
		SHEET	15 OF 37

4.1.2 Operating Mechanism

4.1.2.1

The operating mechanism shall be strong, positive & fast in operation.

4.1.2.2

The circuit breaker mechanism shall preferably be of motor wound charged spring assisted & of trip free design i.e. the trip command always predominating closing command. Where required, manually operated circuit breakers provided with manual spring charged stored energy closing mechanism shall be offered.

4.1.2.3

Circuit breaker operation shall be independent of the motor, which shall be solely for the charging of the spring.

4.1.2.4

Motor wound charged spring mechanism shall be provided with electrical release coil.

4.1.2.5

The mechanism shall preferably be such that:

a)

If the circuit breaker is open and the springs charged, the circuit breaker can be closed & tripped.

b)

If the circuit breaker is closed and the springs charged, there shall be sufficient energy to trip, close & then trip.

4.1.2.6

Circuit breaker operating mechanism shall be fitted with an electrical shunt trip coil in addition to mechanically operated hand-tripping device. The electrical tripping and closing devices shall be suitable for operating from Electrical (AC/DC) supplies as specified under Data Sheet A. The devices shall operate satisfactorily at their rated operating temperature over the following range of voltage variation:

Spring charging motor

85 to 110%

Closing release coil

85 to 110%

Shunt trip coil

70 to 110%

4.1.2.7

All operating coils for use in DC supply shall be connected such that failure of insulation to earth does not cause the coil to be energised.

4.1.2.8

Tripping & closing circuits shall be provided with fuse or miniature circuit breaker in each pole on each unit and shall be independent of each other and all other circuits.

4.1.2.9

Locking facilities shall be provided to prevent the closing of circuit breaker when it is open and from being manually tripped when it is closed. In case it is not possible to provide locking facility to prevent manual tripping suitable shroud or flap shall be provided on the manual trip actuator to prevent its inadvertent operation.

4.1.2.10

Provision shall be made to ensure that when manual-operating mechanism for maintenance purpose is being used, it shall not be possible to electrically close the breaker.

4.1.2.11

All circuit breakers shall incorporate, preferably, both mechanical & electrical anti-pumping features.

4.1.2.12

Limit switches for sensing the circuit breaker position in SERVICE/TEST position & closing

	TITLE GENERAL TECHNICAL REQUIREMENTS OF LV SWITCHGEAR	STD. SPECIFICATION NO.	
		VOLUME	
		SECTION	D
		REV NO. 00	DATE:
		SHEET	16 OF 37

spring CHARGED/DISCHARGED shall be provided.

4.1.3 Isolating Devices

4.1.3.1 All circuit breakers shall be connected to their associated busbars and cables through isolating power contacts of an approved design which shall be arranged for operation while main circuit is live but no current is passing.

4.1.3.2 The design shall be such that it is impossible for the isolating contacts to be opened by force due to current in the primary circuit and shall be inter-locked with the circuit breaker so that it is impossible to make or break current with the isolating contact.

4.1.3.3 When isolation is effected by the withdrawal of the circuit breaker, provision shall be made for positively locating the circuit breaker in the SERVICE, TEST and ISOLATED position. Stops shall be provided to prevent over-travel beyond isolated position and each position shall be clearly indicated.

4.1.3.4 Isolating devices shall incorporate self-aligning contacts, the fixed contacts of which shall be such that access can readily be obtained for maintenance purposes.

4.1.4 Shutters

4.1.4.1 Shutters shall be provided to completely shroud all the fixed isolating contacts of the circuit breaker both on busbar & circuit sides.

4.1.4.2 Shutters shall be opened and closed automatically by the movement of the circuit breaker carriage and shall prevent access to the fixed isolating contacts when the circuit breaker is withdrawn.

4.1.4.3 Painted labels shall be provided to indicate whether the shutters are busbar shutters or cable shutters.

4.1.4.4 The shutter for fixed isolating contacts connected to busbars and cables shall have means for temporarily fixing the shutters in an open position to facilitate inspection or testing.

4.1.4.5 The arrangement of shutters shall be such that normal movement of circuit breaker is not affected.

4.1.5 Contacts and Arc Shields

4.1.5.1 Circuit breaker shall be of single break type. The fixed and moving contact system shall be suitable for easy dismantling and replacement.

4.1.5.2 Circuit breakers shall be provided with an arc control device for each pole, a set of fixed and moving contacts with an arc shield between poles.

4.1.5.3 Arc control devices shall be so placed that any emission shall not cause break down or damage to insulation.

4.1.6 Interlocking and Locking Facilities

4.1.6.1 Mechanical interlocking devices shall be provided to prevent maloperation of the circuit breakers. The list given below comprises the minimum of circuit breaker maloperations that shall be prevented by the use of mechanical interlocking devices.

	TITLE GENERAL TECHNICAL REQUIREMENTS OF LV SWITCHGEAR	STD. SPECIFICATION NO.	
		VOLUME	
		SECTION	D
		REV NO. 00	DATE:
		SHEET	17 OF 37

a) The circuit breaker being withdrawn from or inserted into the primary isolating contacts when the circuit breaker is closed & the plug for secondary disconnection where provided is not fully engaged.

b) The closing of the circuit breaker unless correctly located in the SERVICE, ISOLATED or TEST position.

c) The circuit breaker being closed in the SERVICE position without completing the auxiliary circuits via the secondary isolating devices, where self-aligning secondary isolating contacts have not been provided.

d) The breaker cubicle door being opened unless the breaker is in the OFF (or ISOLATED) condition.

e) Closing of circuit breaker in SERVICE position & door open.

f) Removal of the plug for secondary disconnection when the breaker is in SERVICE position and is ON.

4.1.6.2 Locking facilities shall include the following:

a) Circuit breaker control switch in the neutral position.

b) Mechanical trip on circuit breakers (so as to prevent manual trip). Also refer to clause no.4.1.2.9.

c) Access flaps for operating or withdrawing of circuit breakers.

4.1.7 Circuit Breaker with Releases

4.1.7.1 The circuit breaker, where specified in SEC-C, shall have built-in releases for overload, short circuit, earth fault & under voltage protection depending upon the functional requirements.

4.1.7.2 The short circuit protection employing electromagnetic and overload protection through thermal bimetallic element shall be fed through individual current transformers fitted on each pole of the circuit breaker. However for solid-state protection release, common current transformer for short circuit & overload protection is acceptable.

4.1.7.3 The releases shall act on a common trip bar to trip the circuit breaker.

4.1.7.4 The releases shall be housed such as to make them tamper proof but at the same time easily accessible for carrying out the desired settings.

4.1.7.5 Setting for the overload release shall be through a graduated scale and a fine pointer accessible and visible from the front of the breaker.

4.1.7.6 The short circuit release and under voltage release and earth fault release shall have a clock work timer to delay the tripping and these shall be visible and accessible from front to enable easy adjustments.

4.1.7.7 Facility for testing of all type of release by means of secondary injection shall be provided.

	TITLE GENERAL TECHNICAL REQUIREMENTS OF LV SWITCHGEAR	STD. SPECIFICATION NO.	
		VOLUME	
		SECTION D	
		REV NO. 00	DATE:
		SHEET	18 OF 37

4.1.7.8 Means for remote indication of the release operation shall be provided, if specified in the schemes. This shall be preferably separate for each type of release fitted.

4.1.7.9 Solid State Protection

a) Air circuit breakers may, alternatively, be fitted with composite solid-state protection system comprising of over current, or over current and earth fault protection.

b) The performance of the solid-state protection should have been verified under short circuit conditions.

c) The protection shall be one, which is independent of temperature variations. The protection unit shall not need any external supply for its operation.

d) The overload protection unit shall have inverse time current characteristics.

e) Other common requirements shall be as specified above for electromagnetic releases.

4.1.7.10 A combination of releases or protections for a given circuit breaker feeder type shall be as specified in Data Sheet A.

4.1.8 **Operating Conditions**

4.1.8.1 Breakers controlling motors shall operate satisfactorily under the following conditions:

a) Direct-on-line starting of induction motors rated above 160 kW with a locked rotor current of seven times the rated current and starting time upto 30 seconds.

b) Breaking no load, full load and locked rotor current of induction motors as stated above.

4.2 **CONTACTOR STARTER UNITS**

4.2.1 All motors upto and including 160 kW shall be controlled by Direct-on-line contactor starters, a combination of following:

a) Isolating device;

b) Contactor as main means of starting and stopping of motor;

c) A short circuit protective device (SCPD);

d) Thermal overload protection with built in single phasing prevention feature;

e) Locked rotor protection, if specified in SEC-C.

4.2.2 Hardware to achieve any given type of function shall be as per enclosed schemes.

4.2.3 Withdrawable contactor starter units shall be provided with means for mechanically indicating the SERVICE and other positions of trolley.

4.2.4 The starter units shall carry designation labels in terms of module type codes, signifying the function of the unit. Labels indicating these shall be affixed on fixed and withdrawable portion of the unit.

	TITLE GENERAL TECHNICAL REQUIREMENTS OF LV SWITCHGEAR	STD. SPECIFICATION NO.	
		VOLUME	
		SECTION D	
		REV NO. 00	DATE:
		SHEET	19 OF 37

4.2.5 The units shall be designed to ensure safety of operating personnel.

4.2.6 Interlocks shall be provided to ensure that the unit access door can only be opened when the associated isolating device is open. Defeat interlock facility shall be provided as specified under clause 3.1.22.

4.2.7 The selection of rating of power component and the coordination with protective devices shall be done based on motor rating and characteristics. The type of co-ordination required shall be as specified in Data Sheet A in accordance with applicable standard.

4.2.8 Components of the contactor starter units shall meet the stipulations under clause 5.0.

4.3 **SWITCH FUSE UNITS**

4.3.1 These units shall preferably comprise of switches having integral fuses, called composite units. Alternatively, combination units of separate switch and fuse may also be acceptable.

4.3.2 These units shall be provided for general purpose i.e. incoming or outgoing units on switchgear, where specified in the SEC-C.

4.3.3 The units shall be of the air break air insulated type, and designed to ensure safety to operating personnel.

4.3.4 Composite units shall have integral fuses. The design shall ensure that the moving contact is not live when switch is open i.e. in OFF position, so as to facilitate removal of fuse.

4.3.5 The switch shall be capable of breaking 3 times the normal rated current at 0.3 power factor and 110% rated voltage, and making and carrying the system prospective fault current, but limited in magnitude and duration by the cut off characteristics of the largest HRC fuse link that may be fitted to that unit.

4.3.6 The fixed contact shall be so shrouded that maintenance of the unit can be carried out in safety with the busbars live.

4.3.7 Where one isolating switch is used as the incoming device, the incoming side fixed contacts shall be shrouded to ensure that maintenance can be carried out with the remote fuse and switch closed.

4.3.8 Other common requirements viz. interlocking with access door, interphase barriers, defeat interlock etc. shall be as stipulated elsewhere.

4.3.9 Composite units may also be provided as components in other main assemblies.

4.3.10 Composite switch-fuse or the combination of switch and fuse shall meet the requirements of its components specified in clause 5.0.

4.4 **MOULDED CASE CIRCUIT BREAKERS**

4.4.1 Moulded case circuit breakers (MCCBs) shall be provided when called for in Data Sheet A for use in lieu of switch fuse for the motor controls.

	TITLE GENERAL TECHNICAL REQUIREMENTS OF LV SWITCHGEAR	STD. SPECIFICATION NO.	
		VOLUME	
		SECTION D	
		REV NO. 00	DATE:
		SHEET	20 OF 37

4.4.2 MCCBs in AC circuits shall be of triple pole construction arranged for simultaneous three-pole manual closing and opening and for automatic instantaneous tripping on short circuit.

4.4.3 Power closing device for remote operation may be provided, if indicated in Data Sheet A.

4.4.4 Operating mechanism shall be quick make, quick break and trip free type.

4.4.5 The ON, OFF & TRIP positions of the MCCB shall be clearly indicated so as to be visible to the operator when mounted as in service. Front of board operating handle shall be provided.

4.4.6 MCCBs shall be capable of withstanding the thermal stresses caused by overloads and locked rotor currents/ starting currents of associated motor, and the mechanical stress caused by the peak short circuit current of value associated with the switchgear rating.

4.4.7 The instantaneous short circuit release shall be so chosen as to operate at a current in excess of the peak motor in-rush current and a range of settings shall be provided for the purchaser’s selection.

4.4.8 MCCB terminals shall be shrouded and designed to receive cable lugs for cable sizes relevant to circuit ratings.

4.4.9 Overload inverse time release and other releases shall be provided as specified in Data Sheet A / BOM /Schemes.

4.4.10 MCCB by itself may be provided as component in other main assemblies.

5.0 **SWITCHGEAR COMPONENTS**

5.1 **ISOLATING SWITCH**

5.1.1 All switches shall have visible ON/OFF position indication and shall be pad lockable in any (ON/OFF) position.

5.1.2 The switch shall be capable of making on to the system prospective symmetrical fault current but limited in magnitude and duration by the cut off characteristics of largest HRC fuse link appropriate to the unit.

5.1.3 It shall not be possible to gain access to inside the unit unless the isolating switch is in OFF position.

5.1.4 All isolating switches shall have 1 NO + 1 NC auxiliary contacts. Otherwise multiply where required as per schemes.

5.1.5 The switches shall be suitable for independent manual operation from the front of the switchboard without opening the door.

5.1.6 The switch contacts shall be of silver alloy or silver plated copper and springs of non-corrosive material.

5.1.7 Interphase barriers shall be provided to prevent possibilities of phase-to-phase fault in the switch. The switch shall also be shrouded from all sides to prevent access to live parts on the switch after opening the unit door. The barriers and shrouding shall extend upto the height of switch to fully

	TITLE GENERAL TECHNICAL REQUIREMENTS OF LV SWITCHGEAR	STD. SPECIFICATION NO.	
		VOLUME	
		SECTION D	
		REV NO. 00	DATE:
		SHEET	21 OF 37

enclose both the bus and the load side terminals of the device. The arrangement shall permit easy maintenance.

5.1.8 When used in combination with fuse and contactor;

a) Switch shall be of quick make, quick break type to electrically isolate the starter from the incoming supply. The device shall also interrupt the control supply.

b) Switch shall be capable of disconnecting the load from the busbars in case the contactor has welded in and is carrying the stalled rotor current as high as 8 times full load current at a power factor of 0.3.

5.2 **CONTACTORS**

5.2.1 Contactors shall be of the air break type fitted with arc shields.

5.2.2 The operating coil shall be suitable for satisfactory operation in the range of 85% - 110% of nominal voltage specified under the Data Sheet A. The coil shall be tropicalized having insulation not less than class ‘E’.

5.2.3 Butt contacts of the rolling self-cleaning type shall be utilized and all portions likely to suffer from arcing shall be easily removable.

5.2.4 The contactor shall be capable of closing onto system prospective symmetrical fault current, as specified under Data Sheet A, backed up by the largest HRC fuse appropriate to the rating of the contactor. This capability shall be backed up by test results or calculations based on comparison of let-through energies.

5.2.5 Electrically independent auxiliary contacts not less than 2NO + 2NC for remote interlocking and indication shall be fitted to individual contactor.

5.2.6 Main contacts of contactor shall be silver faced copper.

5.2.7 All springs shall be made out of a corrosion proof material.

5.3 **HIGH RUPTURING CAPACITY (HRC) FUSES**

5.3.1 The fuse serving as the short-circuit protective device in contactor-starter or isolating fuse-switch units shall be of HRC cartridge, current limiting and plug-in/bolted non-deteriorating type.

5.3.2 The fuse carriers shall be easily withdrawable for replacement of fuse. Insulated fuse pullers shall be provided where fuses are not mounted in insulating carriers to remove and replace fuses in live conditions.

5.3.3 Live terminals of fuse bases shall be shrouded to prevent contact with personnel where fuse links are not mounted in carriers and are directly plugged into the fuse base. Interphase barriers extending throughout the length of the fuse base shall be provided to prevent interphase short circuit. They shall be shrouded from all sides to prevent accidental contact.

	TITLE GENERAL TECHNICAL REQUIREMENTS OF LV SWITCHGEAR	STD. SPECIFICATION NO.	
		VOLUME	
		SECTION D	
		REV NO. 00	DATE:
		SHEET	22 OF 37

5.3.4 Fuse carriers and bases shall be of good quality moulded insulating material. Porcelain fuse bases and carriers will not be accepted.

5.3.5 The rating and characteristics of fuse links shall be chosen appropriately for short circuit protection of circuits down stream, while fulfilling the following:

a) Remaining inoperative for transient conditions viz. starting in-rush current of a motor down stream;

b) Matching the thermal withstand characteristics of contactor and thermal overload device to the extent required as per type of coordination.

Condition (b) above is applicable where appropriate.

5.4 **THERMAL OVERLOAD PROTECTION**

5.4.1 All contactor starter for motor shall be provided with ambient temperature compensated thermal overload relay, closely matching the thermal withstand characteristics of motor and affording full protection under all conditions of loading.

5.4.2 Relay shall either have a pair of 1NO + 1NC contact or a set of change over contacts.

5.4.3 The relay shall be hand reset type.

5.4.4 Attention shall be paid to the selection of proper overload relay for motors driving high inertia equipment and having long starting time. Such information shall be furnished to the vendor during detailed engineering.

5.4.5 Relay shall have calibrated dial for site adjustment as per full load current of motor.

5.4.6 Current transformers where used for feeding the thermal over load relays shall be exclusive for this purpose.

5.4.7 The resetting of the relay subsequent to its operation shall be possible without opening the compartment doors.

5.4.8 The setting range of relay chosen shall preferably be 80% - 120% of full load current of corresponding motor, to allow for adjustment at site.

5.4.9 Thermal overload relays shall provide built in single phasing protection upto a minimum of 50% of motor full load current, unless separate single phasing protection is asked for.

5.5 **SINGLE PHASING PREVENTER**

5.5.1 Unidirectional motors, shall have separate means of protection against single phasing and unbalanced voltage.

5.5.2 Single phasing protection shall be of current monitoring type based on the principle of negative phase sequence current detection.

	TITLE GENERAL TECHNICAL REQUIREMENTS OF LV SWITCHGEAR	STD. SPECIFICATION NO.	
		VOLUME	
		SECTION D	
		REV NO. 00	DATE:
		SHEET	23 OF 37

5.5.3 The relay to achieve the protection shall be provided with either a set of change over contacts or a pair of 1 NO + 1 NC contacts.

5.5.4 The relay shall be hand reset type.

5.5.5 The relay shall be stable under such transient conditions as may occur on the system.

5.5.6 The relay shall provide effective protection under all conditions of loading.

5.5.7 The relay shall be inoperative during starting conditions with heavy inrush of each motor.

5.5.8 It shall be possible to reset the relay after its operation without opening the compartment door.

5.6 **INSTRUMENTS AND METERS**

5.6.1 Meters to be fixed in the switchboard shall be panel mounted, flush type and suitable for rear terminal connection.

5.6.2 Meters and instruments shall be enclosed in dust proof; moisture resistant black finished cases and shall be suitable for tropical use. Instruments shall be suitable for operation from the secondary windings of CTs and VTs.

5.6.3 All instruments shall be calibrated to enable direct reading of primary quantities. Instruments shall be adjusted and calibrated at manufacturer’s works and shall have means of calibration, checking and zero adjustment at site.

5.6.4 Instruments pointers movement and instrument case size shall as per data sheet - A. All the divisions and the quantity to be measured shall be clearly marked. Instruments shall conform to applicable standard and shall have class 2 accuracy having black numerals and lettering on white anti- parallax dial with knife-edge pointer. instruments may be of moving iron type or taut band as specified in data sheet - A.

5.6.5 Ammeter, voltmeter and wattmeter shall have scale range 150% of the rated circuit value. In motor circuits, the ammeter shall have suppressed scale to indicate eight times full load current. The ammeter shall have accuracy clause 2.5 for the suppressed scale.

5.6.6 Instruments having metallic cases shall be fitted with earthing terminals.

5.7 **PROTECTIVE AND AUXILIARY RELAYS**

5.7.1 For proper protection of equipment, relays shall be provided on the various circuits as per schemes/ bill of material/ established practices. Relays shall have dust-tight, moisture-proof enclosure and shall be flush mounted type. Relay case shall be painted with dull black or eggshell black enamel and with back connected terminals. Metal cases and frames of relay shall be earthed.

5.7.2 All protection relays shall be of withdrawable type with built-in testing facilities, with provision for inspection, maintenance and replacement. Where built-in test facility is not provided for a particular relay, separate suitable test block shall be provided on the panel for this purpose.

5.7.3 Relays shall have silver to silver contacts with wiping action and shall be capable of making and carrying maximum currents of the associated circuit. Relay contacts shall be capable of breaking such current unless provision is made for breaking such currents elsewhere in the circuit. Contact of the relay shall be capable of repeated operation without deterioration.

	TITLE GENERAL TECHNICAL REQUIREMENTS OF LV SWITCHGEAR	STD. SPECIFICATION NO.	
		VOLUME	
		SECTION D	
		REV NO. 00	DATE:
		SHEET	24 OF 37

5.7.4 Relays, which are connected to complete either the tripping circuits of circuit breaker or the operation, coil of the tripping relay shall be fitted with an externally operated hand reset type mechanical flag indicator. Each indicator shall be provided with inscription to identify the nature of faults. Indicator shall be capable of being reset by hand without opening the relay case.

5.7.5 Relay performance shall not alter due to mechanical shock or vibration or external magnetic field, which may be present at the place of mounting.

5.7.6 Marking for the colour of the phase on which the relay is to be used shall be provided on the front.

5.7.7 Protective relays which initiate tripping shall not have less than two independent pairs of contacts.

5.7.8 Current coils of relays shall be rated for the secondary current of the associated CT.

5.7.9 D.C. relays used for tripping shall operate even when the supply voltage is reduced to 50% of rated voltage.

5.7.10 To minimize the effect of electrolysis, D.C. operating coils shall be so connected in the circuit such that they are not connected to the positive pole of the battery supply except through contacts which are normally open.

5.7.11 The relay ranges and actual settings shall be properly coordinated to achieve adequate discrimination between various electrical equipment in the distribution system and at the same time ensure adequate safety to equipment protected.

5.7.12 The full details of the type of relays and scheme of protection applications for each circuit type shall be as described in specification SEC-C.

5.7.13 Generally, the over current and earth fault protection shall have inverse time characteristics, unless specifically indicated.

5.7.14 Invariably, breaker controlled motor feeders shall be provided with

a) Instantaneous over current protection.

b) Thermal overload protection.

c) Instantaneous earth fault protection.

d) Negative phase-sequence and unbalanced protection.

e) Stalling protection.

All these may be available as a composite relay.

5.8 **CURRENT TRANSFORMERS (CT)**

5.8.1 CTs shall be air insulated having insulation class E or better, cast resin type and shall be capable to withstand the thermal and mechanical stresses resulting from maximum short circuit and momentary current rating of the switchgear.

	TITLE GENERAL TECHNICAL REQUIREMENTS OF LV SWITCHGEAR	STD. SPECIFICATION NO.	
		VOLUME	
		SECTION	D
		REV NO. 00	DATE:
		SHEET	25 OF 37

5.8.2 CTs for air circuit breakers shall be mounted on the fixed portion of the switchgear (except CTs for built in release system) and remote from the busbar.

5.8.3 CT primary current shall be as near as possible to, but not less than the full load thermal rating of the associated circuit. CT secondary shall have either 1Amp or 5Amp rating and polarity shall be marked in a suitable manner. The ratings shall be adequate to cater for the burden of connected instruments and relays, lead resistance and VA burden of remote instruments.

5.8.4 Protection CTs shall have an accuracy limit factor greater or equal to 10 and accuracy class of 5P.

5.8.5 Measuring CTs shall have accuracy class 1.0 and instrument security factor of not more than 5.

5.8.6 Unused CT terminals must be short circuited at the terminal block.

5.8.7 Separate cores of CT shall be used for protection and metering.

5.8.8 CTs shall be of bar primary/ wound primary type capable of carrying the rated primary current.

5.9 **VOLTAGE, CONTROL & HEATING TRANSFORMERS**

5.9.1 Voltage transformers (VT) and control transformers (for contactor operation) shall be dry, cast resin type comprising of single-phase units. They shall have their primary windings protected by current limiting fuses with interrupting capacity corresponding to that of the switchgear.

5.9.2 VT and control transformers secondary windings shall be earthed at the switchgear through link, which can be removed for insulation testing. The earthing shall be in conformity with the schemes enclosed.

5.9.3 All Bus VTs for protection/ metering shall have voltage rating of (Nominal System Voltage / $\sqrt{3}$) / (110 / $\sqrt{3}$)

so that secondary voltage shall be 110 volts phase to phase when the secondary winding is star connected. The accuracy class of protection/metering VTs shall be 1.0. VTs shall have an output rating adequate to cater to the burden connected to them.

5.9.4 Control transformers used for motor contactor operation shall have output rating adequate for proper and satisfactory operation of all the contactors fitted to the switchboard at the maximum secondary transient current with the minimum voltages prevailing on the bus.

5.9.5 Separate control transformer shall be provided for individual motor starter unit.

5.9.6 24 V winding heating transformer shall be provided as per the requirements indicated in Data Sheet A, if motor winding heating is envisaged.

5.10 **SECONDARY FUSES, LINKS AND MCBs**

5.10.1 Secondary circuit shall be protected by a set of fuses or a single fuse link as per requirements of schemes. Carriers and bases for fuses shall be coloured black while carriers and bases for links shall be identified by a white spot on black coloured carrier and base.

5.10.2 The rupturing capacity shall be in conformity with the fault level applicable.

	TITLE GENERAL TECHNICAL REQUIREMENTS OF LV SWITCHGEAR	STD. SPECIFICATION NO.	
		VOLUME	
		SECTION D	
		REV NO. 00	DATE:
		SHEET	26 OF 37

5.10.3 Other common requirements shall be as applicable for primary fuses.

5.10.4 As an alternative to the fuse, if specified in Data Sheet A, the use of miniature circuit breakers (MCBs) combining thermal overload and magnetic short circuit protection shall be permitted for the protection of secondary circuits, provided the correct discrimination and protection is ensured and the MCBs have an adequate rating. The normal ratings as specified in Data Sheet A shall be fulfilled. The protection tripping of these devices shall be adequately guaranteed when used in low fault level circuits viz. on the secondary of voltage transformers.

5.11 **CONTROL AND SELECTOR SWITCHES**

5.11.1 The rating and other features of the switches shall be suitable for the application specified under Data Sheet A for the control and selector switch. The number of position and the number of contacts or ways required for each switch shall be as indicated in schemes enclosed.

5.11.2 Control and selector switches shall be stay put or spring return to neutral type, provided with properly designated escutcheon plates clearly marked to show operating position.

5.11.3 The switches shall be suitable for semi-flush mounting with the front plate and operating handle projecting out. All connection to the switches shall be from the back.

5.11.4 Circuit breaker control switches shall be arranged to operate in an anti-clock wise direction when tripping.

5.11.5 Ammeter selector switches shall have make before break contacts.

5.11.6 The arrangement for front mounting of these devices shall be such as to make them reasonably dust free so as not to interfere with normal operation.

5.12 **INDICATION LAMPS**

5.12.1 Indication lamps shall be cluster type LED.

5.13 **PUSH BUTTONS**

5.13.1 Push button shall be heavy duty, rated appropriately to suit the application.

5.13.2 Push button shall be provided with integral escutcheon plates marked with its function identified as per schemes.

5.13.3 The push button shall be of flush type to prevent inadvertent operation.

5.13.4 Colour shall be appropriate to the function specified.

5.13.5 Minimum number of contacts shall be 2 NO + 2 NC.

5.14 **ANTI-CONDENSATION HEATERS**

5.14.1 Anti-condensation heaters shall be provided inside each panel and shall be designed to operate at black heat from a 240V AC supply but rated for 250 V.

	TITLE GENERAL TECHNICAL REQUIREMENTS OF LV SWITCHGEAR	STD. SPECIFICATION NO.	
		VOLUME	
		SECTION D	
		REV NO. 00	DATE:
		SHEET	27 OF 37

5.14.2 Heaters shall be shrouded and located so as not to cause injury to personnel or damage to equipment.

5.14.3 Wiring to the anti-condensation heater and its control shall be as shown in schemes enclosed.

5.14.4 Each heater shall be provided with thermostat to control the heater for maintaining the panel temperature adjustable within the limits specified under Data Sheet A.

5.15 **GENERAL PURPOSE TIMERS**

5.15.1 General-purpose timers shall meet the requirements stipulated in Data sheet A.

6.0 **PAINTING**

6.1 All metal parts and surfaces (interior & exterior) of the panel shall be degreased by dipping in hot alkaline solution and rubbed with wire brush to remove oil & scale from them & then rinsed in water.
Alternatively, they may be shot blasted.

6.2 Parts shall be pickled by dipping in hydrochloric acid tank to remove the rust from the surfaces formed during storage of sheets & then rinsed to remove traces of the acid. The cleaning and pre-treatment of all metal parts shall be as per applicable standard.

6.3 The surfaces to be painted shall then be prepared by phosphatizing to protect them from further rusting & to create a good bond with the paint. The phosphate coating shall be as per the class and standard indicated in Data Sheet A.

6.4 All parts shall then be subjected to a coat of red oxide/zinc chromate/zinc phosphate primer paint.

6.5 All inside and outside surfaces of panel shall be spray painted with hard semi glossy synthetic enamel of the shade as per Data Sheet A.

6.6 To ensure better appearance, the doors shall be painted, oven dried & baked.

6.7 Paint thickness shall be minimum 50 microns unless specified otherwise in Data Sheet A.

6.8 Electrostatic or powder painting shall be acceptable subject to purchaser’s approval.

6.9 Finished parts shall be coated with peelable compound by spraying method to protect the finished product from scratches, grease, dirty and oily spots during handling and transportation.

7.0 **PACKING**

7.1 A detailed write up on the packing procedure as per manufacturer’s practice shall be submitted by the vendor. Vendor shall incorporate all modifications as suggested by the purchaser. Final packing procedure shall be to the approval of purchaser.

7.2 Specification for the sea worthy packing, if enclosed, for the export jobs shall form part of the specification.

8.0 **GUARANTEED PERFORMANCE REQUIREMENTS**

	TITLE GENERAL TECHNICAL REQUIREMENTS OF LV SWITCHGEAR	STD. SPECIFICATION NO.	
		VOLUME	
		SECTION	D
		REV NO. 00	DATE:
		SHEET	28 OF 37

8.1

The vendor shall guarantee satisfactory performance of the equipment supplied under all conditions and requirement as laid down by this specification.

8.2

For the general requirements of performance guarantees refer to other parts of the specification.

9.0

INSPECTION & TESTS

9.1

Inspection and testing of LV switchgear shall be performed as per Quality Plan /Test Procedure approved during detailed engineering by BHEL/Customer. However, there will not be any commercial implication on account of this.

9.2

All the components and completely assembled switchboards shall be tested as per the latest edition of standards indicated in Annexure I.

9.3

All the specified type and routine tests shall be carried out to verify the rating and performance of the equipment. Where valid type test certificates in evidence of equipment performance claimed are available & approved by purchaser, the requirements for conducting type tests may be waived. The general arrangement of object under test shall be to purchaser’s approval. The type test certificates furnished shall not more than 5 years old. In case type test certificates are not found acceptable, Bidder shall conduct test free of cost.

9.4

General Requirements of testing are as below:

a)

The operating limits for the devices shall be as per Data Sheet A of this specification.

b)

Electrical endurance test on contactors shall be conducted where specified in Data Sheet A.

c)

The number of operating cycles for electrical & mechanical endurance test shall be as per applicable standard.

d)

The short time current duration for current transformer shall be one second.

e)

Verification of type of co-ordination with short circuit protection device in low voltage starter as per applicable standard.

f)

The diversity factor for rated current for temp.rise test shall be 1.0.

9.5

All manufacturing processes viz. machining, sheet forming, electroplating, wire routing, cleating & crimping, assembly, surface preparation shall conform to good manufacturing practice.

9.6

Inspection for dimensional & visual checks especially of the following, with respect to contract drawings, documents & standards shall be conducted:

a)

General sturdiness & rigidity of equipment.

b)

Surface finishing.

c)

Gasketting.

d)

Inter-changeability.

e)

Constructional features viz. location, accessibility & marking of components, segregation, accessibility to live parts (shrouding) etc.

	TITLE GENERAL TECHNICAL REQUIREMENTS OF LV SWITCHGEAR	STD. SPECIFICATION NO.	
		VOLUME	
		SECTION D	
		REV NO. 00	DATE:
		SHEET	29 OF 37

f) Completeness of scope.

9.7 Function tests shall be performed to establish the correct & logical functioning of the electrical, control and protection schemes by simulation or otherwise, where necessary. Stability shall be checked for trip circuit fitted with trip circuit supervision features and any other adjustments.

9.8 Safety interlocking verification shall be done.

10.0 **SPARES**

10.1 A list of spares as per the specification shall be submitted by vendor along with offer..

10.2 Quantities of O & M spares for a duration specified Specification shall be submitted by vendor along with offer.

10.3 The vendor shall indicate any additional start-up and O&M spares and their recommended quantities, which may be required as per vendor’s usual practice. However, the acceptance of the same shall not be binding on purchaser.

11.0 **TOOLS AND TACKLE**

11.1 Tools & tackle, which are essential to facilitate assembly, adjustments, maintenance & dismantling of equipment, shall be provided as part of equipment supplied. These shall include the following:

a) Fuse pullers.

b) All operating handles & tools for operation/ withdrawal of air circuit breakers/ drawout modules.

c) Trucks for removing circuit breaker cassettes.

11.2 The above tools shall be supplied along with the initial consignment of equipment so as to be available prior to erection but may not be used for erection purposes.

11.3 Vendor shall also submit a list of recommended tools and tackle. Acceptance of these tools and tackle shall not be a binding on the purchaser.

11.4 Schedule of tools & tackle shall be filled up by vendor.

12.0 **DOCUMENTATION**

12.1 Purchaser’s documents as part of tender

Purchaser’s schematic drawings and documents being enclosed in the specification are listed in Data Sheet A.

Specification of sea-worthy packing forms part of the specification for export jobs.

12.2 Documents to be submitted by the Bidder along with Bid.

a) Data sheet-C (duly filled in)

	TITLE GENERAL TECHNICAL REQUIREMENTS OF LV SWITCHGEAR	STD. SPECIFICATION NO.	
		VOLUME	
		SECTION D	
		REV NO. 00	DATE:
		SHEET	30 OF 37

b)

Deviations from the technical specification, if any, brought out in the enclosed “Schedule of Deviations” (Volume III).

c)

Schedule of quantities of Mandatory spares.

d)

Schedule of quantities of start-up spares.

e)

Schedule of quantities of O&M spares.

12.3

Documents to be submitted by the vendor after award of contract
(Along with Data Sheet C)

a)

Typical sectional and constructional drawing.

b)

Schematic drawings for each functional unit.

c)

Information on wire routing termination and numbering schemes.

d)

Type Test Certificates.

e)

Final Quality Plans

f)

Catalogues/ leaflets

f)

Bar chart of activities of material procurement, manufacture, assembly, testing and the scheduled dates of completion.

12.4

Documents to be submitted during detailed engineering of contract

a)

All G.A. drawings and single line diagrams

G.A. drawing shall also include the following information:

i.

Busbar & connection materials and size

ii.

Paint shade, exterior & interior

iii.

Front/Rear/Access space

iv.

Weight

v.

Degree of protection

vi.

Bill of material (BOM) to include the following:

i.

List of all the switchboards with their dimensions (LxD1/D2xH), Busbar ratings, operational fronts, and list of auxiliary buses in each one of them in the form of table.

ii.

List containing module size (as part of the panel size) of each type and rating of functional unit (incomer, outgoing and bus-coupler) and each type of auxiliary module.



TITLE

**GENERAL TECHNICAL REQUIREMENTS
OF
LV SWITCHGEAR**

STD. SPECIFICATION NO.

VOLUME

SECTION D

REV NO. 00

DATE:

SHEET

31 OF 37

iii. BOM of each switchboard to include no. of each type and rating of functional units.

iv. BOM of each type and rating of functional unit to include no. of main and auxiliary components and their ratings (kw / Amp.) for the specified loads.

Single line diagram shall include the following information:

- i. Busbar rating
- ii. Load designation
- iii. Load rating kW/Amp
- iv. Module type
- v. Feeder/module number
- vi. Power cable size
- b) Bill of Material.
- c) Characteristic curves:
 - i. Operating characteristics of releases in ACB & MCCB.
 - ii. Time Vs Current characteristic of Overload relay (Hot & Cold characteristic)
 - iii. Time Vs Current characteristic of HRC fuses and pre-arcing / total I^2t data of each fuse rating.
 - iv. Magnetization characteristic of CTs.
 - v. Let through I^2t for MCCB of each rating.
 - vi. Coordination characteristic for each range of combination starters showing type of coordination achieved between different power circuit components.
- d) Field Quality Plan listing the recommended site tests & checks before & after assembly for various shipping sections/ completed switchboards.
- e) Termination charts/ diagrams based on inputs provided by purchaser.
- f) Design calculation/ design checks for following:
 - i. Choosing the power components and ratings viz. coordination of characteristics of starter components.
 - ii. Checking, sizing and coordinating the parameters of components for trip circuit supervision of air circuit breakers.



TITLE

**GENERAL TECHNICAL REQUIREMENTS
OF
LV SWITCHGEAR**

STD. SPECIFICATION NO.

VOLUME

SECTION D

REV NO. 00

DATE:

SHEET

32 OF 37

- g) Heat dissipation data for each module type. Heat dissipation shall cover losses in following current carrying parts of the module/switch board.
- Main circuit comprising of fixed & moving contact (& the contact drop thereof), fuses etc.
 - Associated primary isolation contact mating surfaces (bus side & load side).
 - Common auxiliary units (control transformer, DC supply modules etc.).
 - Horizontal busbars & vertical droppers including all tap offs.

The losses for starter modules shall be based at the full load current specified. For a module serving a range of load ratings, the losses may be based at an average value. Losses for other feeders shall be based at the feeder rating specified.

The base load rating considered shall in any case be mentioned against dissipation figure for each module type. Heat dissipation for busbar & vertical droppers shall be furnished on per unit Length & per unit Amperes basis only. Losses at joints etc. may be included on an average basis in this or given separately for each section. End temperature considered shall also be mentioned by vendor.

Cables losses shall be included for the length inside the panel and shall be furnished where significant.

- h) Static/dynamic loads of all switchboards under normal/abnormal operating conditions.
- i) Operation and maintenance (O&M) manual:

The document shall comprise of vendor's standard instructions for relays, operating and maintenance instructions for circuit breakers etc. and inputs to be provided by purchaser. Compilation and synthesis of the two shall be done by vendor. The O&M manual shall include the following aspects:

- Outline dimension drawings showing constructional features, relevant cross-sectional views and earthing details, operator oriented description of equipment and accessories.
- Rated voltages, current, duty-cycle and all other technical information which may be necessary for correct operation of the switchgear.
- Catalogue numbers of all components liable to be replaced during the life of the switchgear.
- Storage for prolonged duration.
- Unpacking.
- Handling at site.
- Erection.
- Pre-commissioning tests.

	TITLE GENERAL TECHNICAL REQUIREMENTS OF LV SWITCHGEAR	STD. SPECIFICATION NO.	
		VOLUME	
		SECTION D	
		REV NO. 00	DATE:
		SHEET	33 OF 37

ix.

Operating procedures.

x.

Maintenance procedures.

xi.

Precautions to be taken during operation and maintenance work.

j)

Copies of the type, acceptance and routine test certificates in bound volume.

(B)

LOCAL PUSBUTTON STATION AND LOCAL STARTER

1.0

SCOPE

1.1

This specification covers the design, manufacture, inspection & testing at vendor’s works, packing & delivery to site of specified number & type of Local push button station & Local starters.

2.0

CODES & STANDARDS

2.1

Unless specified otherwise in Section – C the latest revision of relevant standards and other applicable statutory rules and regulations are applicable and shall be referred to.

3.0

DESIGN REQUIREMENTS

3.1

Local Push Button Stations are used to control the motors locally. Starters for the motors will be located in motor control centres situated remote.

3.2

Local starters are required to control the motor locally in the field with the Direct-on-line starters for the motor also located near the motor. These will generally receive AC power from remote switchboard.

3.3

Depending on operational requirements and application, these control stations may comprise of various hardwired components as per the enclosed data sheet A & schemes.

3.4

Special care in surface preparation, paint & finish shall be taken for protection against corrosion on units specified for use in salt laden marine atmosphere.

4.0

CONSTRUCTIONAL FEATURES

4.1

General

The local starters shall be suitable for the low voltage distribution system specified. The ratings shall be designed for continuous operation under specified design ambient.

	TITLE GENERAL TECHNICAL REQUIREMENTS OF LV SWITCHGEAR	STD. SPECIFICATION NO.	
		VOLUME	
		SECTION	D
		REV NO. 00	DATE:
		SHEET	34 OF 37

Where requirements common to both Local Push Button Station & Local starters have been specified these have been referred to as `Local control stations.'

4.2 **Enclosure**

4.2.1 The local control station shall be of compact design totally enclosed in sheet steel with a thickness not less than 2.0mm, dust proof & suitable for outdoor use. Degree of protection as specified in Data Sheet A shall be complied with. Push buttons stations for use in Hazardous viz. zone 1, Group IIA areas as per IS: 2148 shall be of flameproof design. Enclosures for outdoor applications shall be weatherproof type with protective canopy. The front cover of Push Button Station enclosure shall be bolted on one side and hinged on the other side. If specified in Data sheet A Local push button station of enclosure of dia cast aluminium of thickness not less than 3mm with bolted type front cover shall be provided.

4.2.2 The enclosure for local starter shall be provided with hinged door in front. The local isolating switch shall be interlocked with the door. Synthetic rubber gasket shall be provided around to ensure efficient sealing of mating surfaces.

4.2.3 Local control stations shall be provided with two earth studs on the outside suitable for connection to the earth conductor size specified in Data Sheet A.

4.3 **Mounting**

The local control stations shall be suitable for surface/wall/column mounting. Fixing bolts shall be supplied along with the stations.

4.4 **Wiring & Terminations**

All wiring inside shall be carried out with 1100 volt grade PVC insulated multi stranded copper wire having a cross section not less than 1.5sq.mm for control & 2.5 sq mm for power. Terminals for External connections shall be stud or insertion type suitable for accepting at least 2 number 2.5 sq mm copper wire. Terminations on all components inside shall be done using crimped lugs. Each wire end shall be identified by a system of ferruling.

4.5 **Cabling**

External cables entering from bottom shall be terminated on the control station. These shall be fitted with bottom removable gland plate suitable for PVC insulated armoured cables of the size & number of cores specified. Double compression Nickel plated brass cable glands shall be suitable for conduit entry of cable. The required cable glands and lugs for power and control cables shall be supplied by the vendor and mounted on gland plate.

4.6 **Indicating Lamps**



TITLE

**GENERAL TECHNICAL REQUIREMENTS
OF
LV SWITCHGEAR**

STD. SPECIFICATION NO.

VOLUME

SECTION D

REV NO. 00

DATE:

SHEET

35 OF 37

Each local push button station/Local starter shall be provided with inscription plate & labels of anodized aluminium/3 layer plastic mentioning the following information.

- Name of drive controlled.
- Label for function of components inside & outside.

All labels/Inscription plate shall be securely fixed on the Local Push Button Station/Local starter body.

4.7 Components**4.7.1 Push button**

Each push button station shall be fitted with 2NO+2NC contacts, unless otherwise specified. Rating & colour for each function shall be as per enclosed Data Sheet A. Push button for initiation shall be shrouded to prevent in advertent operation. Actuator for stop push button shall be one of the following types:

Mush room head with press to latch & key to normalize (Type-1)

Protruding flat head (without shrouding) with a pivoted flap, which can be swung to retain the actuator in depressed position. The flap shall be pad lockable (Type -2)

Control & selector switch

The switches shall be rotary (stay put wing knob) type or spring return (pistol grip) type.

Indicating Lamps

Lamps shall be LED CLUSTER type.

Ammeters

The ammeter shall be of moving iron type 72x72mm size, circular scale 90°, having scale range of 150% of motor rated current and suppressed scale to indicate 800% of rated current. The accuracy class shall be 2 for normal scale and 2.5 for suppressed scale.

Power components

These shall comprise of following for use on local starters.

- Incoming isolating switch (with shrouded incoming side terminals)
- Power fuses
- Contactor

	TITLE GENERAL TECHNICAL REQUIREMENTS OF LV SWITCHGEAR	STD. SPECIFICATION NO.	
		VOLUME	
		SECTION D	
		REV NO. 00	DATE:
		SHEET	36 OF 37
- Over load relay (Bimetal type) with inbuilt single phasing protection and with hand resetting possible without opening doors. - Single phasing preventor - Current transformer for remote/local metering - Control transformers - Control fuses - Push buttons and indicating lamps. The components shall be wired as per approved schemes. Selection of components rating & type shall be in accordance with rating & characteristics of drive and shall ensure co-ordination amongst the characteristics of various components and certain specific requirements if any.			
5.0 <u>INSPECTION & TESTS</u>			
5.1 Identification of enclosure material.			
5.2 Routine & type test certificates of components and finished units.			
5.3 Power frequency high voltage withstand test shall be carried out at 2.5kV for one minute.			
5.4 Valid type test certificates shall be furnished for purchaser’s approval.			
5.5 Inspection for visual and finishing			
- Verification of specifications - Completeness of scope - Markings & Labels - Functional check			
5.6 Inspection shall be carried out as per approved Quality Plan.			
6.0 <u>PAINTING & FINISHING</u>			
6.1 After fabrication all surfaces shall be cleaned and pre-treated as per IS: 6005. One coat of primer (anti corrosive) shall be applied after the pre-treatment. Two coats of epoxy paints to shade no. RAL-7032, unless otherwise specified of different shade in Sec. C/Date sheet A, shall be applied. Thickness of paint shall be minimum 50-60 microns. Protective peelable layer shall be provided on finished surface to protect the painted surface during transportation and site handling.			
6.2 All fixing hardware (bolts, washers) etc. shall be zinc passivated or cadmium plated.			

	TITLE	STD. SPECIFICATION NO.	
	GENERAL TECHNICAL REQUIREMENTS OF LV SWITCHGEAR	VOLUME	
		SECTION D	
		REV NO. 00	DATE:
		SHEET	37 OF 37

7.0

DRAWINGS/DOCUMENTS TO BE SUBMITTED AFTER CONTRACT

7.1

Contract drawings as per agreed vendor drawing schedule.

7.2

Data Sheet C

7.3

Final Quality Plan

7.4

Field Quality Plan

7.6

Bar chart for design, manufacturing, inspection & testing, despatch

7.7

Inspection schedule

7.8

O&M manual

7.9

As built drawings

7.10

Routine & type tests reports.

	DOCUMENT TITLE TECHNICAL SPECIFICATION FOR 1.1 kV PVC POWER CABLES	SPECIFICATION NO.	
		VOLUME	
		SECTION	
		REVISION 0	DATE:
		SHEET 2 OF 3	

TECHNICAL REQUIREMENTS

1.1 Technical requirements for 1.1 kV PVC cables shall be as indicated in this section, in addition to those specified in Section-C and Datasheet-A as attached for project specific requirements.

2.0 QUALITY ASSURANCE REQUIREMENTS

2.1 Bidder shall confirm compliance with the BHEL Quality Plan as attached with the specification without any deviations. Minor changes in Quality Plan (which shall be to customer approval during contract stage) shall be without any commercial implication.

2.2 In the event of BHEL Quality Plan not being applicable for a project (as indicated in section-C of the project specification), the successful bidder shall submit the Manufacturing Quality Plan (MQP) for approval by BHEL/ Owner (as applicable) [during detailed engineering stage without any commercial implications](#).

2.3 Bidders shall submit the list of proven sub-vendors for raw materials, which will be subject to BHEL/ customer approval.

2.4 Type testing requirements and routine/ acceptance testing requirements shall be as detailed below.

2.4.1 Type Tests on Cables

- a. All cables to be supplied shall conform to type tests as per relevant standards and proven type.
- b. The bidder shall furnish the reports of all the type tests listed in Table-1 in Datasheet-A carried out in within last five years of the date of bid opening. These reports should be for the tests conducted either in government approved third party laboratory or witnessed by client (such as major utilities/ industries) on identical/ similar cables to those ordered under this contract.
- c. In case bidder is not able to submit report of type test(s) conducted in last five years, or in case type tests report(s) are not found to be meeting the specification/ relevant standard requirements, then all such tests shall be conducted under this contract by the bidder free of cost to BHEL, and reports shall be submitted for approval. No charges shall be paid for testing under such circumstances. BHEL reserves the right to witness the testing for which due notice shall be given by the vendor.
- d. Irrespective of the bidder furnishing type test report as indicated above, BHEL may get type tests conducted as indicated in Datasheet-A and the same shall be offered for inspection (conduction of type tests shall be witnessed by BHEL). Separate price shall be quoted for the conduction of type testing per lot, which shall be used for cost comparison. A maximum of three lots shall be considered for price comparison purposes on account of type testing. However, type-testing charges shall be paid as per type test conducted.
- e. Minor changes in the final Type Test Procedures (which shall be to approval during contract stage) shall be without any commercial implication.

2.4.2 Routine and Acceptance Tests

- a. Routine testing shall be conducted in line with the applicable standards and as per the Manufacturing Quality Plan approved for the project for every lot offered for inspection.
- b. Acceptance tests shall be conducted on every lot offered for inspection as per details indicated in Datasheet A.
- c. Cost of conduction of routine and acceptance testing shall be deemed to have been included in the quoted supply prices.

	DOCUMENT TITLE TECHNICAL SPECIFICATION FOR 1.1 kV PVC POWER CABLES	SPECIFICATION NO.	
		VOLUME	
		SECTION	
		REVISION 0	DATE:
		SHEET 3 OF 3	

2.4.3 Cost of cables consumed for testing shall be to bidder's account.

3.0 Packing

3.1 Cables shall be supplied in non-returnable heavy construction drums. All wooden parts shall be manufactured from seasoned wood treated with copper naphthenates/ zinc naphthenates (refer IS: 401). All ferrous parts shall be treated with suitable rust protective finish or coating to avoid rusting during transit and storage. BIS certification mark shall be stamped on each cable drum.

4.0 PROJECT SPECIFIC TECHNICAL AND QUALITY DOCUMENTATION TO BE SUBMITTED

4.1 By All Bidders

As technical offer signed and stamped copy of following:

- Section B (Project Information)
- Section C (Specific Technical Requirements)
- Annexure-A to section C (Bill of Quantities)
- Datasheet- A

No other documentation is required to be submitted as technical offer. Any information contained in other parts of the offer (e.g. covering letter, annexures, etc.) which is deviating from specification requirements in any way shall not be considered by BHEL as part of offer.

4.2 By Successful Bidder (for approval during contract stage)

- Stamped copy of Datasheet A (Standard technical particulars & type/ acceptance test schedule as enclosed with technical specification) & Data Sheet-C (vendor specific data) and derating factors in the format provided to the successful bidder along with LOI.
- Cross-section drawings of the cables
- Manufacturing Quality Plan in case BHEL SQP is not applicable.
- List of sub-vendors/ suppliers of raw materials
- Type Test Procedure
- Field Quality Plan
- Technical catalogues/ literature for the cables.

4.3 Two copies of the above documentation shall be submitted for first review. Number of copies to be submitted for second and subsequent submissions (till Cat-I approval is accorded), and those for final distribution prints of approved documentation and test certificates shall be as indicated separately in section C.

4.4 Wherever required, soft copy of all approved technical/ quality documentation shall be submitted as specified without any additional commercial implication. Soft copies may be required both in native file format (e.g. MS Word/ MS Excel) as well as PDF files.

	DOCUMENT TITLE TECHNICAL SPECIFICATION FOR LT CONTROL CABLES	SPECIFICATION NO.	
		VOLUME II B	
		SECTION	
		REVISION 00	DATE:
		SHEET 1 OF 5	

1.0 GENERAL

- 1.1 This section covers the specifications which are applicable in general to PVC insulated, PVC sheathed power and control cables.
- 1.2 Specific requirements of cables as applicable to the project are given in Data Sheet - A of this section.

2.0 STANDARDS

The cable shall conform to the latest edition of following standard in general.

IS : 1554 Part – I(latest) PVC insulated (Heavy duty) Electric Cables
(For working voltage upto and including 1100V)

Other standards are listed in subsequent clauses.

3.0 DESIGN REQUIREMENTS

- 3.1 The cables are proposed to be laid in multi-tier overhead cable racks, in concrete cable trenches. Derating factors for grouping and ambient temperature shall be furnished by successful bidder along with Datasheet-C during contract engineering stage. Cables shall be suitable for laying in metal trays, racks, conduits, ducts or for direct burial in ground both in wet and dry conditions.
- 3.2 All cables shall have flame retardant low smoke (FRLS) type outer sheath, and shall be designed to withstand the mechanical, electrical and thermal stresses under foreseen steady state and transient state fault conditions and shall be suitable for the proposed method of installation.
As applicable to 'FRLS' cables, the overall serving (outer sheath) of the cables shall be of flame retardant low smoke (FRLS) type PVC material.
- 3.3 Cables shall be capable of operating satisfactorily under the power supply, voltage and frequency variations, high ambient, high humid tropical Indian climatic conditions as specified under 'Project Information' in Section-B.

4.0 CONSTRUCTION

- 4.1 Cable construction shall generally conform to the latest edition of applicable standard. For specific requirements refer Data Sheet-A enclosed.

The following p	DOCUMENT TITLE TECHNICAL SPECIFICATION FOR LT CONTROL CABLES	SPECIFICATION NO.	
		VOLUME II B	
		SECTION	
		REVISION 00	DATE:
		SHEET 2 OF 5	

4.2 Identification marks on cable

The following particulars shall be embossed on the outer sheath at intervals of one metre throughout the length of cables.

- i) Manufacturer's name and/or trade name.
- ii) Year of manufacture
- iii) Type of cable and the voltage class.
- iv) Nominal cross sectional area of conductor and number of cores.
- v) Letter HR in case of HR PVC insulated cables.
- vi) Letter FRLS Applicable in case of FRLS cables.

5.0 CORE IDENTIFICATION

5.1 Power Cables

Power cables shall be colour coded for core identification as per IS : 1554, (Part-I)

5.2 Control Cables

- a) Control cables upto 5 cores shall be colour coded as per IS : 1554, (Part-I)
- b) Control cables having more than 5 cores shall have core identification by numbering as per IS : 1554 (Part-I)

6.0 PACKING & MARKING

- 6.1 Cables shall be supplied in non-returnable drums. The drums shall be of heavy construction. All wooden parts shall be manufactured from durable quality wood duly seasoned and treated with copper Naphthenate or Zinc Naphthenate for preserving the wood (ref. IS : 401). All ferrous parts shall be treated with suitable rust protective finish or coating to avoid rusting during transit and storage.
- 6.2 Cable shall be wound and packed on drums in such a manner that it will be protected from injury during transit. Each end of the cables shall be properly sealed and firmly secured to the drum. The ends of each length shall be capped by special PVC/rubber cap

and end embedded in the cable drum flange. The embedded cable ends in drum flange shall be covered by metal sheet.

6.3 The standard drum lengths shall be as indicated in Data Sheet-A

	DOCUMENT TITLE TECHNICAL SPECIFICATION FOR LT CONTROL CABLES	SPECIFICATION NO.	
		VOLUME II B	
		SECTION	
		REVISION 00	DATE:
		SHEET 3 OF 5	

6.4 The tolerance on the dispatched cable length on each drum verified and accepted by Inspector shall be limited to $\pm 5\%$ of the standard drum length. However the overall tolerance on the total dispatched quantity of each size shall be (-) 2% & (+)0%. Cables consumed for testing & inspection will be to bidder's account.

6.5 Short lengths of of individual length not less than 200m, shall be acceptable only in the final drum lengths to meet the overall tolerance limits stipulated above.

6.6 A layer of waterproofed paper shall be applied to the surfaces of the drum and over the outer cable layer.

6.7 A clear space of min. 40 mm shall be left between the cables and logging.

6.8 A label shall be securely attached to each end of reel indicating the Purchaser's order number, length, type, voltage grade, conductor size and number of cores of the cable. A tag containing the same information shall be attached to the leading end of the cable inside.

6.9 BIS Certification mark shall be stamped on each cable drum.

7.0 INSPECTION & TESTING/ QUALITY ASSURANCE

7.1 All materials and components covered under this specification shall be procured, manufactured, inspected & tested as per BHEL standard quality plan No. PED-507-00-Q-002/02 enclosed with the specification, which shall be complied(also refer Cl.no. 3.1.4 for applicable quality plan for the related project). Bidder is to put his seal of acceptance on this quality plan without making any alterations and return the same along with the bid. In case of any comments or deviations, the same are to be furnished in the form of a separate annexure.

7.2 The type, routine and acceptance tests shall be witnessed by inspection agency on one sample for each type as per applicable standards. The sample shall be drawn at the rate of one per type and size for every lot offered for inspection.

7.3 All testing instruments shall be periodically calibrated and calibration certificates shall be shown.

7.4 Special Tests

The following tests as applicable to 'FRLS' cable shall be conducted as type test on each size of each lot to establish the 'FRLS' characteristics of PVC material as applicable to inner sheath/outer sheath of finished cables.

	DOCUMENT TITLE TECHNICAL SPECIFICATION FOR LT CONTROL CABLES	SPECIFICATION NO.	
		VOLUME II B	
		SECTION	
		REVISION 00	DATE:
		SHEET 4 OF 5	

Value for each test shall be as per Data Sheet-A.

- a) **Oxygen Index Test** : This test shall be carried out as per ASTM-D-2863 at room temperature (27⁰C).
- b) **Temperature Index Test** : The test shall be carried out as per ASTM-D-2863 for normal atmospheric oxygen (21% by volume).
- c) **Acid gas Generation during Fire** : The test shall be carried out as per IEC-754-1
- d) **Smoke Generation Test Under Fire** : The test shall be carried out as per ASTM-D-2843.
- e) **Flammability Test** : All finished cables shall pass the following tests :
 - i) Under fire conditions as per IEC-332-III(Category-B).
 - ii) Swedish Chimney test for Class F3 as per SS: 424:1475.
 - iii) Under fire conditions for bunched cables as per IEEE Std. 383/74 (cables shall not be required to have 10Kg. organic material per meter run, as same is not covered in IEEE 383.However test as per IEEE –383 is to be carried out)

7.5 The cable materials shall also pass the following additional type tests.

- a) Heat shock test as per IS : 5831
- b) Loss of mass test as per IS : 5831
- c) Thermal heat stability test as per IS : 5831
- d) Anti termite & anti rodent test (on outer sheath)

8.0 DRAWINGS, DATA & DOCUMENTS REQUIRED

8.1 All the drawings /data sheets / documents to be submitted after award of contract shall be subject to approval of BHEL/CUSTOMER.

8.2 The following information shall be furnished with technical bid

a) Catalogue, cross-sectional drawings.

b) Filled up schedules as per Volume III including Data Sheet-B.

	DOCUMENT TITLE TECHNICAL SPECIFICATION FOR LT CONTROL CABLES	SPECIFICATION NO.	
		VOLUME II B	
		SECTION	
		REVISION 00	DATE:
		SHEET 5 OF 5	

c) Quality plan with seal of acceptance

d) Unfilled price schedule.

8.3 The following information shall be furnished within two weeks after award of contract, for Purchaser's approval:

a) Data Sheet-C.

b) Manufacturing drawings/ details.

c) Recommended field quality plan covering site handling, storing, laying, testing etc.

d) Final quality plan.

e) Packing drawing.

f) Bar chart.

g) Billing schedule.

h) Derating factors.

i) For variation in ambient air temperature from 30 °C to 50 °C in steps of 5 °C.

ii) For variation in ground temperature from 25 °C to 50 °C in steps of 5 °C.

iii) Group derating factors for various configurations of cables laid in overhead trays, trenches, ducts, pipes, directly buried in ground.

iv) For variation in thermal resistivity of soil in the range of 600 mm to 1500 mm.

8.4 The following information shall be furnished after testing and inspection.

Requisite copies of type test, special test, routine and acceptance test reports in bound volume.

LIST OF STANDARD DELIVERABLES FOR SCREENED CONTROL CABLES Doc. No. PE-SD-999-507-E105 Rev. 0		
SL. No.	DOCUMENT TITLE	DWG. / DOCUMENT No.
1	Data Sheet for Screened Control Cables	PE-V0-XXX-507-E501
2	Cross-sectional Drawings for Screened Control Cables	PE-V0-XXX-507-E502
3	Type Test Procedure for Screened Control Cables	PE-V0-XXX-507-E503
4	Quality Plan for Screened Control Cables	PED-507-00-Q-004 (#)
5	Type Test Reports for Tests conducted in last five years	PE-V0-XXX-507-E504
6	Type Test Reports for Tests conducted	PE-V0-XXX-507-E505

XXX : Job Number

(#) : (1) This QP (standard) is applicable for cables specified as per IS.

(2) Incase, Screened Control Cables are as per some other standard (e.g. VDE etc.), vendor to submit their own MQP.

NOTE:

1.) In case of more than one vendor for the package, vendor document number shall contain V1, V2, V3.... etc for each vendor in place of V0.

	TECHNICAL SPECIFICATION FOR ABOVE GROUND EARTHING & LIGHTNING PROTECTION MATERIALS	SPECIFICATION NO. PE-TS-XXX-509-E003
		VOLUME NO. : II-B
		SECTION : C
		REV NO. : 0 DATE :
		SHEET : 1 OF 3

**LIST OF DRAWINGS / DOCUMENTS
TO BE FURNISHED BY SUCCESSFUL BIDDER AFTER AWARD OF CONTRACT**

Sl. No.	Drawings/Document Description	Drawings / Document Number
1.	Technical Data Sheet for Above Ground Earthing & Lightning Protection Materials	PE-V0-XXX-507-E021
2.	GA drawings for Above Ground Earthing & Lightning Protection Materials	PE-V0-XXX-507-E022
3.	Quality Plan for Above Ground Earthing & Lightning Protection Materials	PE-V0-XXX-507-E903

It may please be noted that successful bidder is not to make any fresh submittals at contract stage w.r.t. above mentioned drawings/documents. Technical datasheet, GA drawings & Quality Plan as enclosed in the technical specification is to be appended with cover sheet bearing drawing/document number & description as stated above.

The signed & stamped copy for the same shall be submitted by successful bidder to BHEL within one week of award of contract without making any changes in the contents of the drawing/document.



**TECHNICAL SPECIFICATION FOR
ABOVE GROUND EARTHING & LIGHTNING
PROTECTION MATERIALS**

SPECIFICATION NO.

VOLUME NO. :

SECTION : **D**

REV NO. : DATE :

SHEET : 2 OF 3

1.0 SCOPE OF ENQUIRY

- 1.1 This specification covers the Design, Manufacture, Assembly, Testing and Inspection at vendor's/sub vendor's works, Packing and despatch to site of ABOVE GROUND EARTHING & LIGHTNING PROTECTION MATERIALS as described in various sections of this specification.

2.0 CODES & STANDARDS

- 2.1 The material shall comply with all currently applicable safety codes and statutory regulations of India as well as of the locality where the material is to be installed.
- 2.2 The design, material, construction, manufacture, inspection, testing and performance of "Above ground earthing & Lightning Protection material" shall conform to the latest revision of relevant standards and codes of practices as per Technical datasheet-A.
- 2.3 In case of conflict between the applicable reference standard and this specification, this specification shall govern.

3.0 DESIGN REQUIREMENTS AND CONSTRUCTIONAL FEATURES

- 3.1 All items listed in the BOQ-Cum-Price Schedule for Above Ground Earthing & Lightning Protection Material (Annexure - I of the specification) shall be manufactured as per Technical Datasheet-A and Project drawings enclosed with this specification.
- 3.2 Straight lengths of hot dip galvanised MS materials as per project specific requirement shall be supplied in the standard lengths as below:
- | | | | |
|----|------------------------------|---|----------------------|
| a) | MS Flats of all sizes | : | 4-7 metres |
| b) | SWG wires of different sizes | : | 100 metres (minimum) |
- 3.3 All finished materials (after galvanization) shall be free from sharp edges, corners, burs & unevenness.
- 3.4 Flexible braided Copper Conductor of 600 mm length (cross section equivalent to 300 sq.mm) with tinned copper clamp connected by U-bolt for fence gate earthing as per enclosed drawing no. PE-DG-999-509-E003, Sheet 3 of 4.
- 3.5 Shielding Mast shall be as per enclosed drawing no. PE-DG-999-509-E003, Sheet 4 of 4.

4.0 QUALITY / INSPECTION

- 4.1 The supplier shall perform all tests necessary to ensure that the material and workmanship conform to the relevant standards and comply with the requirements of this specification. Charges for all these tests for all the equipments & components shall be deemed to be included in the bid price.
- 4.2 BHEL's Standard QPs (PED-509-00-Q-001/03) & (PED-507-00-Q-006/02) are enclosed for reference. However, at contract stage, the successful bidder shall submit the QP for BHEL/ ultimate customer's approval. In case bidder has reference QP agreed with ultimate customer, same can be submitted for specific project after award of contract for BHEL/ ultimate customer's approval. There shall be no commercial implication to BHEL on account of QP approval.



**TECHNICAL SPECIFICATION FOR
ABOVE GROUND EARTHING & LIGHTNING
PROTECTION MATERIALS**

SPECIFICATION NO. PE-TS-XXX-509-E003
VOLUME NO. : II-B
SECTION : D
REV NO. : DATE :
SHEET : 3 OF 3

4.3 All materials shall be procured, manufactured, inspected and tested by vendor/ sub-vendor as per approved quality plan.

4.4 At the time of final inspection, 1 sample / lot / size shall be randomly selected by inspector for testing chemical & physical properties at NABL / govt. Approved laboratories. Further, the test certificates shall be submitted to BHEL for review / approval before dispatch of material.

5.0 PACKING

The material shall be packed to ensure protection against damage during transit, storage for prolonged periods and handling.

Test links with Protective boxes & fixing hardware shall be packed separately to avoid damage.

6.0 DELIVERY

The delivery shall be as per NIT (Notice Inviting Tender).

7.0 DOCUMENTATION

7.1 Documents to be submitted by the bidder along with the bid.

- a) A copy of sheet " List of Contents" with bidder's signature & company stamp
- b) A copy of sheet "Instructions to bidders for preparing Technical offer" with bidder's signature & company stamp.
- c) Unpriced copy of "Annexure-I (Bill of Quantities Cum Price Schedule)" with bidder's signature & company stamp.

No other documentation is required to be submitted as technical offer. Any information contained in other parts of the offer (e.g. covering letter, annexures, etc.) which is deviating from specification requirements in any way shall not be considered by BHEL as part of offer.

7.2 Documents to be submitted by successful bidder after award of contract shall be as per Annexure-II.

7.3 Document distribution schedule for the project shall be as per Annexure-III.

		QUALITY PLAN	CUSTOMER :			PROJECT TITLE			SPECIFICATION :				
			BIDDER/ : VENDOR			QUALITY PLAN NUMBER PED-506-00-Q-006, REV-01			NUMBER :				
			SHEET 1 OF 2			SYSTEM			ITEM AC ELECT. MOTORS BELOW 55KW (LV)			SECTION VOLUME III	
SL. NO.	COMPONENT/OPERATION	CHARACTERISTICS CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS	
1	2	3	4	5	6	7	8	9	10	P	W	V	11
1.0	ASSEMBLY	1.WORKMANSHIP	MA	VISUAL	100%	MANUF'S SPEC	MANUF'S SPEC	-DO-	2	-	-		
		2.DIMENSIONS	MA	-DO-	-DO-	MFG. DRG./ MFG. SPEC.	MFG. DRG./ MFG. SPEC.	-DO-	2	-	-		
		3.CORRECTNESS COMPLETENESS TERMINATIONS/ MARKING/COLOUR CODE	MA	VISUAL	100%	MFG.SPEC./ RELEVANT IS	MFG.SPEC. RELEVANT IS	-DO-	2	-	-		
2.0	PAINTING	1.SHADE	MA	VISUAL	SAMPLE	MANUFR'S SPEC/BHEL SPEC./RELEVANT STANDARD	BHEL SPEC. SAME AS COL.7	LOG BOOK	2	-	-		
3.0	TESTS	1.ROUTINE TEST INCLUDING SPECIAL TEST AS PER BHEL SPEC.	MA	-DO-	100%	IS-325/ BHEL SPEC./ DATA SHEET	SAME AS COL.7	TEST REPORT	2	1			NOTE -1 & NOTE-3
		2.OVERALL DIMENSIONS & ORIENTATION	MA	MEASUREMENT & VISUAL	100%	APPROVED DRG/DATA SHEET	APPROVED DRG/DATA SHEET & RELEVANT IS	INSPN. REPORT	2	1	-		NOTE -1 & NOTE-3
BHEL			PARTICULARS			BIDDER/VENDOR							
			NAME										
			SIGNATURE										

		QUALITY PLAN		CUSTOMER :		PROJECT TITLE			SPECIFICATION : NUMBER :			
				BIDDER/ : VENDOR		QUALITY PLAN NUMBER PED-506-00-Q-006, REV-01			SPECIFICATION : TITLE :			
		SHEET 2 OF 2		SYSTEM		ITEM AC ELECT. MOTORS BELOW 55KW (LV)			SECTION		VOLUME III	
SL. NO.	COMPONENT/OPERATION	CHARACTERISTICS CHECK	CAT.	TYPE/METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
1	2	3	4	5	6	7	8	9	P	W	V	11
		3.NAMEPLATE DETAILS	MA	VISUAL	100%	IS-325 & DATA SHEET	IS-325 & DATA SHEET	INSPN. REPORT	2	1	-	
NOTES: 1 ROUTINE TESTS ON 100% MOTORS SHALL BE DONE BY THE VENDOR. HOWEVER, BHEL SHALL WITNESS ROUTINE TESTS ON RANDOM SAMPLES. THE SAMPLING PLAN SHALL BE MUTUALLY AGREED UPON 2 WHERE EVER CUSTOMER IS INVOLVED IN INSPECTION, (1) SHALL MEAN BHEL AND CUSTOMERS BOTH TOGETHER. 3 FOR EXHAUST/VENTILATION FAN MOTORS OF RATING UPTO 1.5KW , ONLY ROUTINE TEST CERTIFICATES SHALL BE FURNISHED FOR SCRUTINY. <u>Legends for Inspection agency</u> 1. BHEL/CUSTOMER 2. VENDOR (MOTOR MANUFACTURER) 3. SUB-VENDOR (RAW MATERIAL/COMPONENTS SUPPLIER) P. PERFORM W. WITNESS V. VERIFY												
BHEL			PARTICULARS		BIDDER/VENDOR					BIDDER'S/VENDORS COMPANY SEAL		
			NAME									
			SIGNATURE									
			DATE									

		QUALITY PLAN		CUSTOMER :			PROJECT TITLE		SPECIFICATION : NUMBER :			
				BIDDER/ : VENDOR			QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03		SPECIFICATION : TITLE			
		SHEET 1 OF 9		SYSTEM			ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)		SECTION		VOLUME III	
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
1	2	3	4	5	6	7	8	9	P	W	V	11
1.0	RAW MATERIAL & BOUGHT OUT CONTROL											
1.1	SHEET STEEL, PLATES, SECTION, EYEBOLTS	1.SURFACE CONDITION	MA	VISUAL	100%	-	FREE FROM BLINKS, CRACKS, WAVINESS ETC	LOG BOOK	3	-	-	
		2.DIMENSIONS	MA	MEASUREMENT	SAMPLE	MANFR'S DRG./SPEC	MANFR'S DRG./SPEC	-DO-	3	-	-	
		3.PROOF LOAD TEST (EYE BOLT)	MA	MECH. TEST	-DO-	-DO-	-DO-	INSPEC. REPORT	3	-	2	
1.2	HARDWARES	1.SURFACE CONDITION	MA	VISUAL	100%		FREE FROM CRACKS, UN-EVENNESS ETC.	-DO-	3	-	-	
		2.PROPERTY CLASS	MA	VISUAL	SAMPLES	MANFR'S DRG./SPEC BOOK	RELEVANT IS/SPEC.	SUPPLIERS TC & LOG	3	-	2	PROPERTY CLASS MARKING SHALL BE CHECKED BY THE VENDOR
1.3	CASTING	1.SURFACE CONDITION	MA	VISUAL	100%		FREE FROM CRACKS, BLOW HOLES ETC.	LOG BOOK	3	-	2	
		2.CHEM. & PHY. PROP.	MA	CHEM & MECH TEST	1/HEAT NO.	MANFR'S DRG./SPEC	RELEVANT IS/	SUPPLIER'S TC	3	-	2	HEAT NO. SHALL BE VERIFIED
		3.DIMENSIONS	MA	MEASUREMENT	100%	MANUFR'S DRG.	MANUFR'S DRG.	LOG BOOK	3	-	2	
1.4	PAINT & VARNISH	1.MAKE, SHADE, SHELF LIFE & TYPE	MA	VISUAL	100% CONTINUOUS	MANFR'S DRG./SPEC	MANFR'S DRG./SPEC	LOG BOOK	3	-	2	
BHEL			PARTICULARS			BIDDER/VENDOR						
			NAME									
			SIGNATURE									
			DATE						BIDDER'S/VENDORS COMPANY SEAL			

		QUALITY PLAN		CUSTOMER :			PROJECT TITLE			SPECIFICATION : NUMBER :			
				BIDDER/ : VENDOR			QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION : TITLE			
		SHEET 2 OF 9			SYSTEM			ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION		VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS	
									P	W	V		
1	2	3	4	5	6	7	8	9	10			11	
1.5	SHAFT (FORGED OR ROLLED)	1. SURFACE COND.	MA	VISUAL	100%	-	FREE FROM VISUAL DEFECTS	-DO-	3	-	-	VENDOR'S APPROVAL IDENTIFICATION SHALL BE MAINTAINED	
		2. CHEM. & PHYSICAL PROPERTIES	MA	CHEM. & PHYSICAL TESTS	1/HEAT NO. OR HEAT TREATMENT BATCH NO	MFG. DRG. SPEC.	RELEVANT IS	SUPPLIER'S TC	3	-	2		
		3. DIMENSIONS	MA	MEASUREMENT	100%	-DO-	MANUFR'S DRG.	LOG BOOK	3	-	2		
		4.INTERNAL FLAWS	CR	UT	-DO-	ASTM-A388	MANUFR'S SPEC. BHEL SPEC.	-DO-	3	2	1		
1.6	SPACE HEATERS, CONNECTORS, TERMINAL BLOCKS, CABLES, CABLE LUGS, CARBON BRUSH TEMP. DETECTORS, RTD, BTD'S	1. MAKE & RATING	MA	VISUAL	-DO-	MANUFR'S DRG. SPEC.	MANUFR'S DRG. SPEC.	-DO-	3	-	2	FOR DIA OF 55 MM & ABOVE	
		2. PHYSICAL COND.	MA	-DO-	-DO-	-	NO PHYS. DAMAGE, NO ELECTRICAL DISCONTINUITY	-DO-	3	-	2		
		3.DIMENSIONS (WHEREVER APPLICABLE)	MA	MEASUREMENT	SAMPLE	MANUFR'S DRG./ SPEC.	MANUFR'S DRG. / SPEC.	-DO-	3	-	2		
		4.PERFORMANCE/ CALIBRATION	MA	TEST	100%	-DO-	-DO-	INSP. REPORT	3	-	2		
BHEL			PARTICULARS			BIDDER/VENDOR							
			NAME										
			SIGNATURE										
			DATE										
												BIDDER'S/VENDORS COMPANY SEAL	

		QUALITY PLAN SHEET 3 OF 9		CUSTOMER :		PROJECT			SPECIFICATION :				
				BIDDER/		TITLE			NUMBER :				
				VENDOR		QUALITY PLAN			SPECIFICATION :				
		SYSTEM		NUMBER PED-506-00-Q-007, REV-03			TITLE			SECTION			
				ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			VOLUME III						
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS	
									P	W	V		
1	2	3	4	5	6	7	8	9	10			11	
1.7	OTHER INSULATING MATERIALS LIKE SLEEVES, BINDINGS CORDS, PAPERS, PRESS BOARDS ETC.	1. SURFACE COND. ETC. 2. OTHER CHARACTERISTICS	MA MA	VISUAL TEST	100% SAMPLE	- MANUF'S SPEC.	NO VISUAL DEFECTS MANUF'S SPEC.	INSPT. REPORT LOG BOOK AND OR SUPPLIER'S TC	3 3	- -	2 2		
1.8	SHEET STAMPING (PUNCHED)	1. SURFACE COND. 2.DIMENSIONS INCLUDING BURS HEIGHT 3. ACCEPTANCE TESTS	MA MA MA	VISUAL MEASUREMENT ELECT. & MECH TESTS	100% SAMPLE -DO-	- MANUFR'S DRG. . MANUF'S SPEC./ RELEVANT IS	NO VISUAL DEFECTS (FREE FROM BURS) MANUFR'S DRG. RELEVANT IS	LOG BOOK -DO- SUPPLIER'S TC	3 3 3	- - -	- 2 2		FOR MV MOTOR INSULATION/VARNISH THICKNESS SHALL BE MORE THAN THE BURS HEIGHT
1.9	CONDUCTORS	1. SURFACE FINISH 2.ELECT. PROP. & MECH. PROP	MA MA	VISUAL ELECT. & MECH.TEST	100% SAMPLES	- RELEVANT IS/ BS OR OTHER STANDARDS	FREE FROM VISUAL DEFECTS RELEVANT IS/ BS OR OTHER STANDARDS	LOG BOOK SUPPLIERS TC & VENDOR'S INSPN. REPORTS	3* 3	- -	2* 2		* MOTOR MANUFACTURER TO CONDUCT VISUAL CHECK FOR SURFACE FINISH ON RANDOM BASIS (10% SAMPLE) AT HIS WORKS AND MAINTAIN RECORD FOR VERIFICATION BY BHEL/CUSTOMER.
BHEL			PARTICULARS			BIDDER/VENDOR							
			NAME										
			SIGNATURE										
			DATE										
												BIDDER'S/VENDORS COMPANY SEAL	

		QUALITY PLAN SHEET 4 OF 9		CUSTOMER :		PROJECT			SPECIFICATION :			
				BIDDER/ :		TITLE			NUMBER :			
				VENDOR		QUALITY PLAN			SPECIFICATION :			
				SYSTEM		ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			TITLE			
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	SECTION			VOLUME III
									P	W	V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
1.10	BEARINGS	3.DIMENSIONS	MA	MEASUREMENT	-DO-	-DO-	-DO-	Log Book	3	-	2	
		1.MAKE & TYPE	MA	VISUAL	100%	MANFR'S DRG./ APPROVED DATASHEET	MANFR'S DRG./ APPROVED DATASHEET	-DO-	3	-	2	
		2.DIMENSIONS	MA	MEASUREMENT	SAMPLE	BHEL DATA SHEET	BHEL DATA SHEET BEARING MANUF'S CATALOGUES	-DO-	3	-	2	
		3.SURFACE FINISH	MA	VISUAL	100%	-	FREE FROM VISUAL DEFECTS	-DO-	3	-	2	
1.11	SLIP RING (WHEREVER APPLICABLE)	1.SURFACE COND.	MA	VISUAL	100%	-	-DO-	-DO-	3	-	-	
		2.DIMENSIONS	MA	MEASUREMENT	SAMPLE	MANUF'S DRG	MANUF'S DRG	-DO-	3	-	-	
		3.TEMP.WITH-STAND CAPACITY	MA	ELECT.TEST	-DO-	MANUF'S SPEC./ BHEL SPEC.	MANUF'S SPEC./ BHEL SPEC.	-DO-	3	-	2	
		4.HV/IR	MA	-DO-	100%	-DO-	-DO-	-DO-	3	-	2	
1.12	OIL SEALS & GASKETS	1.MATERIAL OF GASKET	MA	VISUAL	100%	MANUF'S DRG/SPECS	MANUF'S DRG./ SPECS.	-DO-	3	-	-	
		2.SURFACE COND.	MA	VISUAL	100%	-	FREE FROM VISUAL DEFECTS	-DO-	3	-	-	
		3.DIMENSIONS	MA	MEASUREMENT	SAMPLE	MANUF'S DRG	MANUF'S DRG	-DO-	3	-	-	
BHEL			PARTICULARS			BIDDER/VENDOR						
			NAME									
			SIGNATURE									
			DATE									
									BIDDER'S/VENDORS COMPANY SEAL			

		QUALITY PLAN		CUSTOMER :			PROJECT TITLE			SPECIFICATION : NUMBER :		
				BIDDER/ : VENDOR			QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION : TITLE		
		SHEET 5 OF 9		SYSTEM			ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION		VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
1	2	3	4	5	6	7	8	9	P	W	V	11
2.0	IN PROCESS											
2.1	STATOR FRAME WELDING (IN CASE OF FABRICATED STATOR)	1.WORKMANSHIP & CLEANNES	MA	VISUAL	100%	-DO-	GOOD FINISH	LOG BOOK	3/2	2	-	
		2.DIMENSIONS	MA	MEASUREMENT	-DO-	MANUF'S DRG	MANUF'S DRG	-DO-	2	-	-	
2.2	MACHINING	1.FINISH	MA	VISUAL	100%	-DO-	GOOD FINISH	LOG BOOK	2	-	-	
		2.DIMENSIONS	MA	MEASUREMENT	-DO-	MANUF'S DRG	MANUF'S DRG	-DO-	2	-	-	
		3.SHAFT SURFACE FLOWS	MA	PT	-DO-	RELEVANT SPEC./ ASTM-E165	MANUF'S SPEC./ BHEL SPEC./	-DO-	2	-	1	
2.3	PAINTING	1.SURFACE PREPARATION	MA	VISUAL	100%	MANFR'S SPEC./BHEL SPEC./ RELEVANT STAND	BHEL SPEC. SAME AS COL.7	LOG BOOK	2	-	-	
		2.PAINT THICKNESS (BOTH PRIMER & FINISH COAT)	MA	MEASUREMENT BY ELCOMETER	SAMPLE	-DO-	-DO-	-DO-	2	-	-	
		3.SHADE	MA	VISUAL	-DO-	-DO-	-DO-	Log Book	2	-	-	
		4.ADHESION	MA	CROSS CUTTING & TAPE TEST	-DO-	-DO-	-DO-	Log Book	2	-	-	
BHEL			PARTICULARS			BIDDER/VENDOR						
			NAME									
			SIGNATURE									
			DATE						BIDDER'S/VENDORS COMPANY SEAL			

		QUALITY PLAN		CUSTOMER :			PROJECT		SPECIFICATION :			
				BIDDER/ :			TITLE		NUMBER :			
				VENDOR			QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03		SPECIFICATION : TITLE			
SHEET 6 OF 9		SYSTEM			ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION			VOLUME III	
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
									P	W	V	
1	2	3	4	5	6	7	8	9	10			11
2.4	SHEET STACKING	1.COMPLETENESS	MA	MEASUREMENT	SAMPLE	MANUFR'S SPEC.	MANUFR'S SPEC.	Log Book	2	-	-	(FOR MOTORS OF 2MW AND ABOVE) * ON 10% RANDOM SAMPLE
		2.COMPRESSION & TIGHTENING	MA	MEASUREMENT	100%	-DO-	-DO-	Log Book	2	-	-	
		3.CORE LOSS & HOTSPOT	MA	ELECT.TEST	-DO-	-DO-	-DO-	Log Book	2	1*	1	
2.5	WINDING	1.COMPLETENESS	CR	VISUAL	100%	MANUFR'S SPEC./BHEL SPEC.	MANUFR'S SPEC./BHEL SPEC.	Log Book	2	-	-	FOR MV MOTOR
		2.CLEANLINESS	CR	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	-	
		3.IR-HV-IR	CR	ELECT. TEST	-DO-	-DO-	-DO-	Log Book	2	-	1	
		4.RESISTANCE	CR	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	1	
		5.INTERTURN INSULATION	CR	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	-	
		6.SURGE WITH STAND AND TAN. DELTA TEST	CR	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	1	
2.6	IMPREGNATION	1.VISCOSITY	MA	PHY. TEST	AT STARTING	-DO-	-DO-	Log Book	2	-	-	THREE DIPS TO BE GIVEN
		2.TEMP. PRESSURE VACCUM	MA	PROCESS CHECK	CONTINUOUS	-DO-	-DO-	Log Book	2	-	-	
		3.NO. OF DIPS	MA	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	1	
BHEL			PARTICULARS			BIDDER/VENDOR						
			NAME									
			SIGNATURE									
			DATE									
									BIDDER'S/VENDORS COMPANY SEAL			

		QUALITY PLAN SHEET 7 OF 9		CUSTOMER :			PROJECT TITLE			SPECIFICATION : NUMBER :		
				BIDDER/ : VENDOR			QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION : TITLE		
				SYSTEM			ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION VOLUME III		
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
1	2	3	4	5	6	7	8	9	10	11	12	13
2.7	COMPLETE STATOR ASSEMBLY	4.DURATION	MA	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	1	VERIFICATION FOR MV MOTOR ONLY
		1.COMPACTNESS & CLEANLINESS	MA	VISUAL	100%	-DO-	-DO-	Log Book	2	-	-	
2.8	BRAZING/COMPRESSION JOINT	1.COMPLETENESS	CR	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	-	
		2.SOUNDNESS	CR	MALLET TEST & UT	-DO-	-DO-	-DO-	Log Book	2		1	
		3.HV	MA	ELECT. TEST	-DO-	-DO-	-DO-	Log Book	2		1	
2.9	COMPLETE ROTOR ASSEMBLY	1.RESIDUAL UNBALANCE	CR	DYN. BALANCE	-DO-	MFG SPEC./ ISO 1940	MFG. DWG.	Log Book	2		1	
		2.SOUNDNESS OF DIE CASTING	CR	ELECT. (GROWLER TEST)	-DO-	MFG. SPEC.	MFG. SPEC.	Log Book	2		1	
2.10	ASSEMBLY	1.ALIGNMENT	MA	MEAS.	-DO-	-DO-	-DO-	Log Book	2	-	-	
		2.WORKMANSHIP	MA	VISUAL	-DO-	-DO-	-DO-	Log Book	2	-	-	
		3.AXIAL PLAY	MA	MEAS.	-DO-	-DO-	-DO-	Log Book	2	-	1	
		4.DIMENSIONS	MA	-DO-	-DO-	MFG.DRG./ MFG SPEC.	MFG. DRG/ RELEVANT IS	Log Book	2	-	-	
		5.CORRECTNESS, COMPLETENESS TERMINATIONS/ MARKING/ COLOUR CODE	MA	VISUAL	100%	MFG SPEC. RELEVANT IS	MFG SPEC. RELEVANT IS	Log Book	2	-	-	
		6. RTD, BTD & SPACE HEATER MOUNTING.	MA	VISUAL	100%	MFG SPEC. RELEVANT IS	MFG SPEC. RELEVANT IS	Log Book	2		1	
BHEL			PARTICULARS			BIDDER/VENDOR						
			NAME									
			SIGNATURE									
			DATE									
												BIDDER'S/VENDORS COMPANY SEAL

		QUALITY PLAN SHEET 8 OF 9		CUSTOMER :		PROJECT			SPECIFICATION :			
				BIDDER/ :		TITLE			NUMBER :			
				VENDOR		QUALITY PLAN			SPECIFICATION :			
		SYSTEM		NUMBER PED-506-00-Q-007, REV-03			TITLE					
		ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)		SECTION			VOLUME III					
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
									P	W	V	
1	2	3	4	5	6	7	8	9	10			11
3.0	TESTS	1.TYPE TESTS INCLUDING SPECIAL TESTS AS PER BHEL SPEC.	MA	ELECT.TEST	1/TYPE/SIZE	IS-325/ BHEL SPEC./ DATA SHEET	IS-325/ BHEL SPEC./ DATA SHEET	TEST REPORT	2	1*	1	* NOTE - 1
		2.ROUTINE TESTS INCLUDING SPECIAL TEST AS PER BHEL SPEC.	MA	-DO-	100%	-DO-	-DO-	-DO-	2	1 ^s	1	\$ NOTE - 2
		3.VIBRATION & NOISE LEVEL	MA	-DO-	100%	IS-12075 & IS-12065	IS-12075 & IS-12065	-DO-	2	1 ^s	1	\$ NOTE - 2
		4.OVERALL DIMENSIONS AND ORIENTATION	MA	MEASUREMENT & VISUAL	100%	APPROVED DRG/DATA SHEET	APPROVED DRG/DATA SHEET & RELEVANT IS	INSPC. REPORT	2	1	-	
		5.DEGREE OF PROTECTION	MA	ELECT. & MECH. TEST	1/TYPE/ SIZE	RELEVANT IS	BHEL SPEC. AND DATA SHEET	TC	2	-	1	TC FROM AN INDEPENDENT LABORATORY, REFER NOTE-3
		6. MEASUREMENT OF RESISTANCE OF RTD & BTD	MA	-DO-	100%	-DO-	-DO-	-DO-	2	1 ^s	1	\$ NOTE - 2
		7. MEASUREMENT OF RESISTANCE, IR OF SPACE HEATER	MA	-DO-	100%	-DO-	-DO-	-DO-	2	1 ^s	1	\$ NOTE - 2
		8. NAMEPLATE DETAILS	MA	VISUAL	100%	IS-325 & DATA SHEET	IS-325 & DATA SHEET	INSPC. REPORT	2	1 ^s	1	\$ NOTE - 2
		9.EXPLOSION FLAME PROOF NESS (IF SPECIFIED)	MA	EXPLOSION FLAME PROOF TEST	1/TYPE	IS-3682 IS-8239 IS-8240	IS-3682 IS-8239 IS-8240	TC	2	-	1	TC FROM AN INDEPENDENT LABORATORY, REFER NOTE-3
		10. PAINT SHADE, THICKNESS & FINISH	MA	VISUAL & MEASUREMENT BY ELKOMETER	SAMPLE	BHEL SPEC. & DATA SHEET	BHEL SPEC. & DATA SHEET	TC	2	1 ^s	1	SAMPLING PLAN TO BE DECIDED BY INSPECTION AGENCY \$ NOTE - 2
BHEL			PARTICULARS		BIDDER/VENDOR							
			NAME									
			SIGNATURE									
			DATE					BIDDER'S/VENDORS COMPANY SEAL				

		QUALITY PLAN SHEET 9 OF 9		CUSTOMER :		PROJECT TITLE			SPECIFICATION : NUMBER :			
				BIDDER/ VENDOR		QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION : TITLE			
				SYSTEM		ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION VOLUME III			
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
									P	W	V	
1	2	3	4	5	6	7	8	9	10			11
NOTES: 1 DEPENDING UPON THE SIZE AND CRITICALLY, WITNESSING BY BHEL SHALL BE DECIDED. 2 ROUTINE TESTS ON 100% MOTORS SHALL BE DONE BY THE VENDOR. HOWEVER, BHEL SHALL WITNESS ROUTINE TESTS ON RANDOM SAMPLES. THE SAMPLING PLAN SHALL BE MUTUALLY AGREED UPON. 3 IN CASE TEST CERTIFICATES FOR THESE TESTS ON SIMILAR TYPE, SIZE AND DESIGN OF MOTOR FROM INDEPENDENT LABORATORY ARE AVAILABLE, THESE TEST MAY NOT BE REPEATED. 4 WHEREVER CUSTOMER IS INVOLVED IN INSPECTION, AGENCY (1) SHALL MEAN BHEL AND CUSTOMERS BOTH TOGETHER. <u>Legends for Inspection agency</u> 1. BHEL/CUSTOMER 2. VENDOR (MOTOR MANUFACTURER) 3. SUB-VENDOR (RAW MATERIAL/COMPONENTS SUPPLIER) P. PERFORM W. WITNESS V. VERIFY												
BHEL			PARTICULARS			BIDDER/VENDOR						
			NAME									
			SIGNATURE									
			DATE									
										BIDDER'S/VENDORS COMPANY SEAL		

		QUALITY PLAN		CUSTOMER :		PROJECT TITLE :		SPECIFICATION NO. :				
				BIDDER/ VENDOR :		STANDARD QP NO. : PE-QP-999-509-E001, REV. 0		SPECIFICATION TITLE:				
		SHEET 1 OF 2		SYSTEM EARTHING		ITEM : EARTHING & LIGHTNING PROTECTION MATERIALS			DOC. NO. :			
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
1	2	3	4	5	6	7	8	9	P	W	V	11
1.0	RAW MATERIAL											
1.1	MILD STEEL (FLATS & RODS) AS PER SPECIFICATION	1.CHEMICAL & PHYSICAL PROPERTIES	MA	VERIFICATION, OF TC'S	100%	IS:2062	IS:2062	MILL TC	3	-	1/2	Refer note in Remark at Sl. No.3
		2.DIMENSIONS	MA	MEASUREMENT	100%	IS - 1730	IS - 1730	QC RECORD	3/2	-	-	
		3.SURFACE FINISH	MA	VISUAL	100%	IS : 1079	IS : 1079	QC RECORD	3/2	-	-	
1.2	ZINC	1.CHEM.COMP.	MA	CHEM.TEST	SAMPLE	IS - 209	IS - 209	QC RECORD	3/2	-	1/2	
2.0	IN-PROCESS											
2.1	CUTTING, DRILLING	1.DIMENSIONS	MA	MEASUREMENT	100%	APP. DATA SHEET/ APP. DRAWING	APP. DATA SHEET/ APP. DRAWING	QC RECORD	2	-	1	
		2.SURFACE FINISH	MA	VISUAL	100%	FREE FROM DEFECTS & SLAG	FREE FROM DEFECTS & SLAG	QC RECORD	2	-	1	
2.2	SURFACE PREPARATION	1.CLEANING PICKLING, RINSING, & FLUXING	MA	VISUAL	PERIODIC IN EACH SHIFT	IS:2629	IS:2629	QC RECORD	2	-	-	
		2.SURFACE QUALITY	MA	VISUAL	100%	IS:2629	IS:2629	QC RECORD	2	-	-	
BHEL			PARTICULARS		BIDDER/VENDOR							
			NAME									
			SIGNATURE									
			DATE					BIDDER'S/VENDORS COMPANY SEAL				
LEGEND : 1 - BHEL/ CUSTOMER 2 - VENDOR 3 - SUB- VENDOR P - PERFORM W - WITNESS V - VERIFICATION												

		QUALITY PLAN		CUSTOMER :		PROJECT TITLE :			SPECIFICATION NO. :			
				BIDDER/ VENDOR :		STANDARD QP NO. : PE-QP-999-509-E001 REV. 0			SPECIFICATION TITLE:			
		SHEET 2 OF 2		SYSTEM EARTHING		ITEM : EARTHING & LIGHTNING PROTECTION MATERIALS			DOC. NO. :			
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
									P	W	V	
1	2	3	4	5	6	7	8	9	10			11
2.3	GALVANISING	1.TEMPERATURE OF BATH	MA	TEMPERATURE INDICATOR	CONTINUOUS	IS - 2629	IS - 2629	QC RECORD	3/2	-	-	If vendor doesn't have his own galvanizing plant duly approved by BHEL PEM; then galvanizing shall be carried out at BHEL-PEM approved other galvanizing plants as per Annexure-2.
		2. DROSS	MA	VISUAL	PERIODIC	IS - 2629	IS - 2629	QC RECORD	3/2	-	-	
		3. RATE OF IMMERSION	MA	VISUAL/ MEASUREMENT	100%	IS - 2629/ MFRS PRACTICE	IS - 2629/ MFRS PRACTICE	QC RECORD	3/2	-	2	
		4.SURFACE QUALITY	MA	VISUAL	100%	IS - 2629	FREE FROM BURRS, ROUGHNESS, SLAG, FLUX, STAIN ETC.	QC RECORD	3/2	-	-	
3.0	FINISHED ITEMS	1. CHEMICAL	MA	CHEMICAL	1 No./LOT/SIZE	IS-2062	IS-2062	LAB TC	2	-	1	Note : Sample shall be selected by BHEL & testing shall be done at NABL/ govt. approved lab
		2.DIMENSIONS	MA	MEASUREMENT	IS 2500 (PART 1 LEVEL S-4	APP. DATA SHEET/ APP. DRAWING	APP. DATA SHEET/ APP. DRAWING	INSP. REPORT	2	1	-	
		3.SURFACE FINISH	MA	VISUAL	IS 2500 (PART 1 LEVEL S-4	FREE FROM BURRS, SLAG, ROUGHNESS, FLUX, STAIN, ETC.	FREE FROM BURRS, SLAG, ROUGHNESS, FLUX, STAIN, ETC.	INSP. REPORT	2	1	-	
		4.MASS OF ZINC COATING	MA	CHEM. TEST	IS - 4759	IS-6745 / APP. DATA SHEET	APP. DATA SHEET	INSP. REPORT	2	1	-	
		5.UNIFORMITY OF ZINC COATING	MA	CHEM. TEST	IS - 4759	IS-2633	IS-2633	INSP. REPORT	2	1	-	
		6.THICKNESS OF ZINC COATING	MA	ELCOMETER	IS - 4759	APP. DATA SHEET	APP. DATA SHEET	INSP. REPORT	2	1	-	
		6.ADHESION	MA	MECH.TEST	IS-4759	IS-2629	IS-2629	INSP. REPORT	2	1	-	
BHEL			PARTICULARS			BIDDER/VENDOR						
			NAME									
			SIGNATURE									
			DATE						BIDDER'S/VENDORS COMPANY SEAL			

LEGEND : 1 - BHEL/ CUSTOMER 2 - VENDOR 3 - SUB- VENDOR P - PERFORM W - WITNESS V - VERIFICATION

		STANDARD QUALITY PLAN		CUSTOMER :		PROJECT:		SPECIFICATION			
				BIDDER/		TITLE		NUMBER :			
				VENDOR		QUALITY PLAN		SPECIFICATION :			
SHEET 1 OF 9		SYSTEM		ITEM : LT XLPE Power Cables		SECTION		VOLUME III			
SL. NO.	COMPONENT/ OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY	REMARKS	
1	2	3	4	5	6	7	8	9	10	11	
Instructions: 1. Cable manufacturer to maintain records to show co-relation of raw materials to finished cables i.e. raw material batch/ lot no. should be traceable to the final cable drum number or batch no. 2. Cable manufacturer to maintain all quality records identified as per all QP stages enumerated below whether it is identified for BHEL verification or witness or not.											
1.0	RAW MATERIALS & BOUGHT OUT ITEMS										
1.1	Aluminium Rods (Conductor/ Armour Wire)	GENERAL : 1. Physical properties 2. Elec.Properties SPECIFIC CHECKS : a) Make b) Grade c) Resistivity	MA	Physical Tests	Sample/ Batch	IS:7098-I,IS:5082, IS:5484, IS:8130 & Appd Datasheet	IS:7098-I,IS: 5082, IS:5484, IS:8130 & Appd Datasheet	Log book/ Test Cert.	3/2	-	1/2
			MA	Electrical Tests	Sample/ Batch	-do-	-do-	-do-	3/2	-	1/2
			MA	Verify	100%	Manufacturer approved source	Manufacturer approved source	Log book/ Test Cert.	3/2	-	1
			MA	-do-	-do-	IS 8130, IS 5082/ Approved datasheet	IS 8130, IS 5082/ Approved datasheet	-do-	3/2	-	1
			MA	Electrical Tests	Manufacturer std.	IS 8130, IS 5082	IS 8130, IS 5082	-do-	3/2	-	1
1.2	XLPE Compound for insulation	GENERAL : 1. Physical properties 2. Elec.Properties SPECIFIC CHECKS : a) Make b) Type/ Grade c) Shelf life/ Storage condition	MA	Physical Tests	Sample/ Batch	IS 7098-I & Mfs Std./ Approved datasheet	IS 7098-I & Mfs Std./ Approved datasheet	Log book/ Test Cert.	3/2	-	1/2
			MA	Electrical Tests	Sample/ Batch	-do-	-do-	-do-	3/2	-	1/2
			MA	Verify	100%	Manufacturer approved source	Manufacturer approved source	Log book/ Test Cert.	3/2	-	1
			MA	-do-	-do-	Mfr. Std/ Approved datasheet	Mfr. Std/ Approved datasheet	-do-	3/2	-	1
			MA	-do-	-do-	Compound Manufacturer std.	Compound Manufacturer std.	-do-	3/2	-	1
BHEL			PARTICULARS		BIDDER/VENDOR						
			NAME								
			SIGNATURE								
			DATE				BIDDER'S/VENDORS COMPANY SEAL				

		STANDARD QUALITY PLAN		CUSTOMER :			PROJECT: TITLE			SPECIFICATION NUMBER :		
				BIDDER/ VENDOR			QUALITY PLAN NUMBER: PE-QP-999-507-E002, R0			SPECIFICATION : TITLE		
		SHEET 2 OF 9		SYSTEM			ITEM : LT XLPE Power Cables			SECTION VOLUME III		
SL. NO.	COMPONENT/ OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
									P	W	V	
1	2	3	4	5	6	7	8	9	10			11
1.3	PVC Compound (for sheath)	GENERAL :										
		1. Physical properties	MA	Physical Tests	Sample/ Batch	IS 7098-I, IS 5831& Mfr. Std./ Approved datasheet	IS 7098-I, IS 5831& Mfr. Std./ Approved datasheet	Log book/ Test Cert.	3/2	-	1/2	
		2. Elec.Properties	MA	Electrical Tests	Sample/ Batch	-do-	-do-	-do-	3/2	-	1/2	
		3. FRLS Properties (as applicable)	CR	Chemical/ Environ.	Sample/ Batch	-do-	-do-	-do-	3/2	-	1/2	
		SPECIFIC CHECKS :										
		a) Make	MA	Verify	100%	Manufacturer approved source	Manufacturer approved source	Log book/ Test Cert.	3/2	-	1	
		b) Type/ Grade	MA	-do-	-do-	Approved datasheet	Approved datasheet	-do-	3/2	-	1	
		c) Shelf life/ Storage condition	MA	-do-	-do-	Compound Manufacturer std.	Compound Manufacturer std.	-do-	3/2	-	1	
1.4	Fillers (as applicable)	1. Make	MA	Verify	100%	Manufacturer approved source	Manufacturer approved source	Log book/ Test Cert.	3/2	-	1	
		2. Type/ Grade	MA	-do-	-do-	Approved datasheet	Approved datasheet	-do-	3/2	-	1	(Fillers material chosen shall be compatible with the temerature rating of the cable and shall have no deleterious effect on any other componenet of the cable)
BHEL			PARTICULARS			BIDDER/VENDOR						
			NAME									
			SIGNATURE									
			DATE						BIDDER'S/VENDORS COMPANY SEAL			

		STANDARD QUALITY PLAN		CUSTOMER :			PROJECT: TITLE			SPECIFICATION NUMBER :		
				BIDDER/ VENDOR			QUALITY PLAN NUMBER: PE-QP-999-507-E002, R0			SPECIFICATION : TITLE		
		SHEET 3 OF 9		SYSTEM			ITEM : LT XLPE Power Cables			SECTION VOLUME III		
SL. NO.	COMPONENT/ OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
1	2	3	4	5	6	7	8	9	P	W	V	11
1.5	Galvanised steel wire/strip for Armour (as applicable)	GENERAL : 1. Make 2. Dimension 3. Phy.and Elec. Properties 4.Galvanization Quality	MA	Verify	Manufacturer std.	Manufacturer approved source	Manufacturer approved source	Log book/ Test Cert.	3/2	-	1	* Sample from each armour size/ Batch / Lot
			MA	Measurement	-do-	IS 7098-I, IS 3975 & Approved datasheet	IS 7098-I, IS 3975 & Approved datasheet	-do-	3/2	-	2	
			MA	Physical & Electrical Tests	Sample*	-do-	-do-	-do-	3/2	-	2	
			MA	Galv.Tests	-do-	IS 3975 & Mfr. Std.	IS 3975 & Mfr. Std.	-do-	3/2	-	2	
1.6	Wooden Drum	1. Phy. & Constructional checks	MA	Visual	Mfr's Plant Std.	IS 10418	IS 10418	Log book/ Test Cert.	3/2	-	1	# (If Applicable)
		2. Anti termite treatment	MA	Chem.	Mfr's Plant Std.	Mfr's Plant Std.	Mfr's Plant Std.	COC	3/2		1	
1.7	Steel Drum #	1. Dimension	MA	Meas.	Mfr's Plant Std.	Mfr's Plant Std.	Mfr's Plant Std.	Log book/ Test Cert.	3/2	-	1	# (If Applicable)
		2. Surface finish	MA	Meas.	-do-	Surface shall be smooth	Surface shall be smooth	-do-	3/2		1	
BHEL			PARTICULARS			BIDDER/VENDOR			BIDDER'S/VENDORS COMPANY SEAL			
			NAME									
			SIGNATURE									
			DATE									

		STANDARD QUALITY PLAN		CUSTOMER :			PROJECT TITLE			SPECIFICATION : NUMBER :		
				BIDDER/ VENDOR :			QUALITY PLAN NUMBER: PE-QP-999-507-E002, R0			SPECIFICATION : TITLE		
				SYSTEM			ITEM : LT XLPE Power Cables			SECTION VOLUME III		
SHEET 4 OF 9												
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
1	2	3	4	5	6	7	8	9	P	W	V	11
2.0	IN PROCESS											
2.1	Wire Drawing	1. Size	MA	Dimensional	Plant Mfg. Std.	IS 8130 & Appd. Datasheet	IS 8130 & Appd. Datasheet	Log Book	2	-	1	
		2. Surface finish	MA	Visual	-do-	Surface shall be smooth	Surface shall be smooth	-do-	2	-	1	
		3. % of Elongation	MA	Mechanical	-do-	IS 8130 & Appd. Datasheet	IS 8130 & Appd. Datasheet	-do-	2	-	1	
2.2	Stranding of wires	1. No. of wires	MA	Counting	Plant Mfg. Std.	IS 8130 & Appd. Datasheet	IS 8130 & Appd. Datasheet	Log Book	2	-	-	
		2. Resistance	CR	Electrical	-do-	-do-	-do-	-do-	2	-	-	
		3. Sequence, lay length & Direction	MA	Visual, Meas.	One Sample of each size/ lot	Mfrs Std. / Appd. Datasheet	Mfrs Std. / Appd. Datasheet	-do-	2	-	-	
		4. Surface Finish	MA	Visual	100%	Surface shall be smooth	Surface shall be smooth	-do-	2	-	-	
		5. Dimension	MA	Measurement	One Sample of each size/ lot	IS 8130 & Appd. Datasheet	IS 8130 & Appd. Datasheet	-do-	2	-	-	
2.3	Core Insulation (XLPE) (No repair permitted)	1. Surface finish	MA	Visual	100%	Free from bulging, burnt particles, lumps, cuts & scratches	Free from bulging, burnt particles, lumps, cuts & scratches	Log Book	2	-	1	
		2. Eccentricity & Ovality #	CR	Measurement	One Sample of each size/ lot	IS 7098-I & Appd. Datasheet	IS 7098-I & Appd. Datasheet	-do-	2	-	1	# To be checked at starting & finished end of extruded length.
		3. Insulation Thickness	CR	Measurement	-do-	-do-	-do-	-do-	2	-	-	
		4. Dia over insulation	MA	Measurement	-do-	-do-	-do-	-do-	2	-	-	
		5. Tensile Strength & % Elongation	MA	Mechanical	100%	-do-	-do-	-do-	2	-	-	
		6. Spark Test or Water immersion test	CR	Electrical	100%	Mnfr's Std	Mnfr's Std	-do-	2	-	1	
BHEL			PARTICULARS			BIDDER/VENDOR						
			NAME									
			SIGNATURE									
			DATE						BIDDER'S/VENDORS COMPANY SEAL			

		STANDARD QUALITY PLAN		CUSTOMER :		PROJECT TITLE			SPECIFICATION : NUMBER :				
				BIDDER/ VENDOR :		QUALITY PLAN NUMBER: PE-QP-999-507-E002, R0			SPECIFICATION : TITLE				
				SYSTEM		ITEM : LT XLPE Power Cables			SECTION VOLUME III				
SHEET 5 OF 9													
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS	
1	2	3	4	5	6	7	8	9	10	11	12	13	
2.4	Core Laying	1. Dia over laid up core 2. Sequence of lay & direction 3. Lay Length	MA MA MA	Measurement Visual & Meas. Measurement	One Sample of each size/ lot -do- -do-	IS 7098-I & Appd. Datasheet IS 7098-I & Mfr. Std. -do-	IS 7098-I & Appd. Datasheet IS 7098-I & Mfr. Std. -do-	Log Book -do- -do-	2 2 2	- - -	- - -	(Pimple, fish eye, porosity & burnt particles not permitted.)	
2.5	InnerSheath Extrusion (as applicable)	1. Surface finish 2. Thickness 3. Dia over inner sheath	MA CR MA	Visual Measurement -do-	100% One Sample of each size/ lot -do-	Surface shall be smooth IS 7098-I & Appd. Datasheet -do-	Surface shall be smooth IS 7098-I & Appd. Datasheet -do-	Log Book -do- -do-	2 2 2	- - -	- - -		
2.6	Armour(as applicable)	1. No.of wires/Strips 2. Lay length & Direction 3. Dia over armouring 4. Coverage	MA MA MA MA	Counting Visual & Meas. Measurement Measurement	At the start of the process -do- -do- -do-	IS 7098-I & Appd. Datasheet IS 7098-I & Mfr. Std. IS 7098-I & Appd. Datasheet -do-	IS 7098-I & Appd. Datasheet IS 7098-I & Mfr. Std. IS 7098-I & Appd. Datasheet -do-	Log Book -do- -do- -do-	2 2 2 2	- - - -	- - - -		
2.7	Outer Sheath Extrusion (No repair permitted)	1. Surface finish 2. Sheath Thickness 3. Dia over outer sheath 4. Embossing/ Sequential Marking	MA CR MA MA	Visual Measurement -do- Visual	100% One Sample of each size/ lot -do- 100%	Surface shall be smooth IS 7098-I & Appd. Datasheet -do- Approved data sheet	Surface shall be smooth IS 7098-I & Appd. Datasheet -do- Approved data sheet	Log Book -do- -do- -do-	2 2 2 2	- - - -	- - - -		(Pimple, fish eye, porosity & burnt particles not permitted.)
BHEL			PARTICULARS			BIDDER/VENDOR							
			NAME										
			SIGNATURE										
			DATE						BIDDER'S/VENDORS COMPANY SEAL				

		STANDARD QUALITY PLAN		CUSTOMER :			PROJECT		SPECIFICATION :			
				BIDDER/ VENDOR :			TITLE		NUMBER :			
				SHEET 6 OF 9			QUALITY PLAN		SPECIFICATION :			
			SYSTEM			NUMBER: PE-QP-999-507-E002, R0		TITLE				
			ITEM : LT XLPE Power Cables			SECTION		VOLUME III				
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
1	2	3	4	5	6	7	8	9	P	W	V	11
3.0	Finished Cable (INTERNAL)	1. Routine Test (Refer Note-F)	CR	Electrical Tests & Measurement	100%	IS 7098-I & Appd. Datasheet	IS 7098-I & Appd. Datasheet	Test Report	2	-	1	# Refer Annexure-A to QAP enclosed
4.0	Final Inspection (EXTERNAL)	1. Finish	MA	Visual	One drum in each Lot	IS 7098-I & Appd. Datasheet	Free from Porosity, Bulging, Burnt particles,lumps, cuts & Approved Data Sheet	Test Report	2	1	-	
		2. Length	MA	Measurement	-do-	-do-	-do-	-do-	2	1	-	
		3. Dimension	MA	-do-	As per IS	-do-	-do-	-do-	2	1	-	
		4. Armouring - Coverage & No.of Wires/Strips	MA	Visual & Meas.	-do-	-do-	-do-	-do-	2	1	-	
		5. Marking & Colour Coding	MA	Visual	As per IS	-do-	Approved Data Sheet	-do-	2	1	-	
		6. Acceptance Tests (Refer Note-F)	CR	Phy, Elect. Tests & FRLS Tests	-do-	-do-	-do-	-do-	2	1	-	
		7. Type Tests (Refer Note-F)	CR	Physical & Electrical Tests	Sample #	-do-	-do-	-do-	2	1	-	
5.0	Packing	Sealing Identification	MA	Visual	100%	As per IS	As per IS	-do-	2	1	-	
NOTES:- (A) JOINTS IN WIRE SHALL BE AS PERMITTED BY IS / MANUFACTURER'S STANDARD, VENDOR TO CERTIFY THE SAME. (B) NO REPAIR OF CORE INSULATION PERMITTED (C) RECORD OF RAW MATERIAL, PROCESS & ALL STAGES SHALL BE CERTIFIED BY VENDORS QC. AND ARE LIABLE TO AUDIT CHECK BY PURCHASER. (D) FILLERS/DUMMY CORES ETC. SHALL BE AS PER APPROVED DATA SHEET (E) VENDOR SHALL FURNISH COMPLIANCE CERTIFICATE TO THE INSPECTION AGENCY CONFIRMING THE PACKING AS PER BHEL SPECIFICATION. (F) FOR LIST OF ROUTINE, TYPE & ACCEPTANCE TESTS, REFER ANNEXURE-A TO QAP ENCLOSED.												
LEGEND : P : PERFORMER W: WITNESSER V: VERIFIER 1- BHEL/CUSTOMER 2-VENDOR 3- SUB VENDOR CHP:CUSTOMER HOLD POINT WHICH WILL BE DECIDED AT CONTRACT STAGE												
BHEL			PARTICULARS			BIDDER/ VENDOR						
			NAME									
			SIGNATURE									
			DATE						BIDDER'S/VENDORS COMPANY SEAL			

	ANNEXURE-A TO QAP	CUSTOMER:	PROJECT TITLE:	SPECIFICATION NUMBER:
		BIDDER/VENDOR:	QUALITY PLAN NUMBER : PE-QP-999-507-E002, R0	SPECIFICATION TITLE:
	SHEET 8 OF 9	SYSTEM	ITEM: LT XLPE POWER CABLES	DOC. NO.

S. No.	TEST	APPLICABLE FOR	TEST CONDUCTION REQUIRED AS	REFERENCE STANDARD	REMARKS
VI.	Resistivity test	Applicable for Aluminium wire & GS wire	A	IS 10810 Pt 42	
VII.	Uniformity of Zinc coating test	For G. S. wires/Strip only	A	IS 10810 Pt 40	
VIII.	Mass of Zinc coating test	For G. S. wires/Strip only	A	IS 10810 Pt 41	
IX.	Wrapping Test	For Aluminium wires only	A	IS 10810 Pt 3	
3.0	<u>Physical Tests for XLPE Insulation & PVC sheath</u>				
I.	Test for thickness	Applicable for XLPE insulation, PVC inner sheath & PVC outer sheath	T, A	IS 10810 Pt 6	
II.	Tensile strength and elongation test at break	Applicable for XLPE insulation & PVC outer sheath			
(a)	Before ageing		T, A	IS 10810 Pt 7	
(b)	After ageing		T, A	IS 10810 Pt 7	
III.	Ageing in air oven	Applicable for XLPE insulation & PVC outer sheath	T	IS 10810 Pt 11	
IV.	Loss of mass in air oven test	For PVC outer sheath only	T	IS 10810 Pt 10	
V.	Hot deformation test	For PVC outer sheath only	T	IS 10810 Pt 15	
VI.	Heat shock test	For PVC outer sheath only	T	IS 10810 Pt 14	
VII.	Shrinkage test	For XLPE insulation & PVC outer sheath only	T	IS 10810 Pt 12	
VIII.	Thermal stability test	For PVC outer sheath only	T	IS 10810 Pt 60	
IX.	Hot set test	For XLPE insulation only	T, A	IS 10810 Pt 30	
X.	Water absorption (gravimetric) test	For XLPE insulation only	T	IS 10810 Pt 33	
4.0	<u>Improved Fire performance (FR-LSH) Tests</u>				
I.	Oxygen index test	For PVC outer sheath only	T, A	IS 10810 Pt 58 / ASTMD 2863	Applicable for Inner Sheath also, if the same is indicated in Datasheet-A
II.	Smoke density test	For PVC outer sheath only	T, A	IS 10810 Pt 63 / ASTMD 2843	
III.	Acid gas generation test	For PVC outer sheath only	T, A	IS 10810 Pt 59 / IEC-754-1	
IV.	Temperature Index Test	For PVC outer sheath only	T	IS 10810 Pt 64 / ASTMD 2863	
5.0	<u>Flammability Tests</u>				
I.	Flammability test for bunched cables	For complete cable	T	IS 10810 Pt 62/ IEC-60332 (Part-3-23-Cat-B/Cat-A,	Test & Category applicable as indicated in Datasheet-A
II.	Flammability test for single cable	For complete cable	T, A	IS: 10810 Pt 61 / IEC:60332 Part-1	
III.	Swedish chimney test	For complete cable	A	SEN SS 424 1475 (Class F3)	
IV.	Flammability test	For complete cable	A	IEEE: 60383	

BHEL	PARTICULARS	BIDDER/ VENDOR	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S / VENDORS COMPANY SEAL

	ANNEXURE-A TO QAP SHEET 9 OF 9	CUSTOMER:	PROJECT TITLE:	SPECIFICATION NUMBER:
		BIDDER/VENDOR:	QUALITY PLAN NUMBER : PE-QP-999-507-E002, R0	SPECIFICATION TITLE:
		SYSTEM	ITEM: LT XLPE POWER CABLES	DOC. NO.

S. No.	TEST	APPLICABLE FOR	TEST CONDUCTION REQUIRED AS	REFERENCE STANDARD	REMARKS
6.0	Electrical Tests				
I.	High Voltage Test	For complete cable	T, A, R	IS 10810 Pt 45	
II.	Insulation Resistance Test (Volume resistivity method)	For complete cable	T, A	IS 10810 Pt 43	
7.0	Anti-rodent and Termite Repulsion test	For PVC outer sheath only	A	--	Test applicable if indicated in Datasheet-A
8.0	Anti-Fungal Test	For PVC outer sheath only	A	--	
9.0	Special Tests				
I.	Hydrolytic Stability Test	For complete cable	**	ASTM D 3137:81	Test applicable if indicated in Datasheet-A
II.	Ultraviolet Radiation Test	For complete cable	**	BS EN ISO 4892-2	

**** These tests shall be conducted on one sample for the entire contract and duration of these tests shall be 14 days.**

BHEL	PARTICULARS	BIDDER/ VENDOR	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S / VENDORS COMPANY SEAL

		QUALITY PLAN SHEET 1 OF 8		CUSTOMER :		PROJECT TITLE		SPECIFICATION : NUMBER : PE-TS-XXX-507-E003			
				BIDDER/ : VENDOR		QUALITY PLAN NUMBER PE-QP-999-507-E003, R-0		SPECIFICATION TITLE			
SL. NO.	COMPONENT/OPERATION	CHARACTERISTICS CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	SECTION AGENCY		VOLUME III REMARKS
1	2	3	4	5	6	7	8	9	10	11	
Instructions: 1. Cable manufacturer to maintain records to show co-relation of raw materials to finished cables i.e. raw material batch/ lot no. should be traceable to the final cable drum number or batch no. 2. Cable manufacturer to maintain all quality records identified as per all QP stages enumerated below whether it is identified for BHEL verification or witness or not.											
1.0	RAW MATERIAL										
1.1	Copper Rods/ Aluminum Rod/ Wires (Al:- For Conductor & Armour) (Cu:- For Conductor)	GENERAL : 1. Physical properties 2. Elec.Properties SPECIFIC CHECKS : a) Make b) Grade c) Resistivity	MA	Physical Tests	Sample per Batch	IS 1554 Pt-1/ IS 613/ IS 5082 & Approved datasheet	IS 1554 Pt-1/ IS 613/ IS 5082 & Approved datasheet	Log book/ Test Cert.	3/2	1/2	
			MA	Electrical Tests	Sample per Batch	IS 1554 Pt-1/ IS 613/ IS 5082 & Approved datasheet	IS 1554 Pt-1/ IS 613/ IS 5082 & Approved datasheet	Log book/ Test Cert.	3/2	1/2	
			MA	Verify	100%	Manufacturer approved source	Manufacturer approved source	Log book/ Test Cert.	3/2	1	
			MA	-do-	-do-	IS 613/IS 5082 & Approved datasheet	IS 613/ IS 5082 & Approved datasheet	Log book/ Test Cert.	3/2	1	
			MA	Electrical Tests	Manufacturer std.	IS 613/ IS 5082	IS 613/ IS 5082	Log book/ Test Cert.	3/2	1	
1.2	PVC Compound (for insulation)	GENERAL : 1. Physical properties 2. Elec.Properties SPECIFIC CHECKS : a) Make b) Type/ Grade c) Shelf life/ Storage condition	MA	Physical Tests	Sample per batch	IS 1554 Pt-1/ IS 5831 & Approved datasheet	IS 1554 Pt-1/ IS 5831 & Approved datasheet	Log book/ Test Cert.	3/2	1/2	
			MA	Electrical Tests	Sample per batch	IS 1554 Pt-1/ IS 5831 & Approved datasheet	IS 1554 Pt-1/ IS 5831 & Approved datasheet	Log book/ Test Cert.	3/2	1/2	
			MA	Verify	100%	Manufacturer approved source	Manufacturer approved source	Log book/ Test Cert.	3/2	1	
			MA	Verify	100%	Mfrs std / Approved datasheet	Mfrs std / Approved datasheet	Log book/ Test Cert.	3/2	1	
			MA	Verify	100%	Compound Manufacturer std.	Compound Manufacturer std.	Log book/ Test Cert.	3/2	1	
1.3	Fillers (as applicable)	1. Make 2. Flame retardant & moisture resistant. (as applicable)	MA	Verify	100%	Manufacturer approved source	Manufacturer approved source	Log book/ Test Cert.	3/2	1	
			CR	Chemical/ Environ.	100%	Approved datasheet	Approved datasheet	Log book/ Test Cert.	3/2	2	
BHEL			PARTICULARS		BIDDER/VENDOR						
			NAME								
			SIGNATURE								
			DATE				BIDDER'S/VENDORS COMPANY SEAL				

		QUALITY PLAN		CUSTOMER :			PROJECT TITLE		SPECIFICATION : NUMBER : PE-TS-XXX-507-E003				
BIDDER/ VENDOR				QUALITY PLAN NUMBER PE-QP-999-507-E003, R-0		SPECIFICATION : TITLE							
SHEET 2 OF 8				SYSTEM		ITEM :HRPVC/ PVC POWER & CONTROL CABLE			SECTION		VOLUME III		
SL. NO.	COMPONENT/OPERATION	CHARACTERISTICS CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY	P	W	V	REMARKS
1	2	3	4	5	6	7	8	9	10			11	
1.4	Galvanised steel wire/strip for Armour (if applicable)	GENERAL : 1. Make 2. Dimension 3. Phy.and Elec. Properties 4.Galvanization Quality	MA	Verify	Manufacturer std.	Manufacturer approved source	Manufacturer approved source	Log book/ Test Cert.	3/2	-	1	* Sample from each size/ Batch/ Lot	
			MA	Measurement	Manufacturer std.	IS 1554 Pt-1/ IS 3975	IS 1554 Pt-1/ IS 3975	Log book/ Test Cert.	3/2	-	2		
			MA	Physical & Electrical Tests	Sample*	IS 1554 Pt-1/ IS 3975	IS 1554 Pt-1/ IS 3975	Log book/ Test Cert.	3/2	-	2		
			MA	Galv.Tests	Sample*	IS 1554 Pt-1/ IS 3975	IS 1554 Pt-1/ IS 3975	Log book/ Test Cert.	3/2	-	2		
1.5	PVC compound for Sheath	GENERAL : 1. Physical properties 2. Elec.Properties 3. FRLS Properties (as applicable) SPECIFIC CHECKS : a) Make b) Type/ Grade c) Shelf life/ Storage condition	MA	Physical Tests	Sample per batch	IS 1554 Pt-1/ IS 5831 & Approved datasheet	IS 1554 Pt-1/ IS 5831 & Approved datasheet	Log book/ Test Cert.	3/2	-	1/2		
			MA	Electrical Tests	Sample per batch	IS 1554 Pt-1/ IS 5831	IS 1554 Pt-1/ IS 5831	Log book/ Test Cert.	3/2	-	1/2		
			CR	Chemical/ Environ.	Sample per batch	IS 1554 Pt-1/ IS 5831 & Approved datasheet	IS 1554 Pt-1/ IS 5831 & Approved datasheet	Log book/ Test Cert.	3/2	-	1/2		
			MA	Verify	100%	Manufacturer approved source	Manufacturer approved source	Log book/ Test Cert.	3/2	-	1		
			MA	Verify	100%	IS 1554 Pt-1/ IS 5831 & Approved datasheet	IS 1554 Pt-1/ IS 5831 & Approved datasheet	Log book/ Test Cert.	3/2	-	1		
			MA	Verify	100%	Compound Manufacturer std.	Compound Manufacturer std.	Log book/ Test Cert.	3/2	-	1		
1.6	Wooden drums	1. Phy. & Constructional checks	MA	Visual	Mfr's Plant Std.	IS 10418	IS 10418	Log book/ Test Cert.	3/2	-	1	# (If applicable)	
		2. Anti termite treatment	MA	Chem.	Mfr's Plant Std.	Mfr's Plant Std.	Mfr's Plant Std.	COC	3/2	-	1		
1.7	Steel drums #	1. Dimension	MA	Meas.	Mfr's Plant Std.	Mfr's Plant Std.	Mfr's Plant Std.	Log book/ Test Cert.	3/2	-	1		
		2. Surface finish	MA	Meas.	Mfr's Plant Std.	Mfr's Plant Std.	Mfr's Plant Std.	Log book/ Test Cert.	3/2	-	1		
2.0 IN PROCESS													
2.1	Wire Drawing & Annealing.	1. Size 2. Surface finish 3. % of Elongation	MA MA MA	Dimensional Visual Mechanical	Plant Mfg. Std. Plant Mfg. Std. Plant Mfg. Std.	IS 1554 Pt-1 / IS 8130 & Approved Data Sheet Surface shall be smooth IS 1554 Pt-1 / IS 8130	IS 1554 Pt-1 / IS 8130 & Approved Data Sheet Surface shall be smooth IS 1554 Pt-1 / IS 8130	Log Book Log Book Log Book	2 2 2	- - -	1 1 1	(Applicable only for tin-coated copper conductor)	
2.2	Tinning (For Conductor)	1. Size	MA	Dimensional	Plant Mfg. Std.	Approved datasheet	Approved datasheet	Log Book	2	-	1		
		2. Chemical test for Tinning (if applicable)	CR	Chemical Test	Sample	IS 1554 Pt-1/ IS:8130 & Mfrs Std	IS 1554 Pt-1/ IS:8130 & Mfrs Std	Log Book	2	-	-		
BHEL			PARTICULARS			BIDDER/VENDOR							
			NAME										
			SIGNATURE										
			DATE										
BIDDER'S/VENDORS COMPANY SEAL													

		QUALITY PLAN SHEET 3 OF 8		CUSTOMER :		PROJECT TITLE			SPECIFICATION : NUMBER : PE-TS-XXX-507-E003				
				BIDDER/ VENDOR		QUALITY PLAN NUMBER PE-QP-999-507-E003, R-0			SPECIFICATION : TITLE				
				SYSTEM		ITEM : HRPVC/ PVC POWER & CONTROL CABLE			SECTION VOLUME III				
SL. NO.	COMPONENT/OPERATION	CHARACTERISTICS CHECK	CAT.	TYPE/METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS	
1	2	3	4	5	6	7	8	9	10	P	W	V	11
2.3	Stranding of wires	1. No. of wires	MA	Counting	Plant Mfg. Std.	IS 1554 Pt-1 / IS 8130 & Approved Data Sheet	IS 1554 Pt-1 / IS 8130 & Approved Data Sheet	Log Book	2	-	-		
		2. Resistance	CR	Electrical	Plant Mfg. Std.	IS 1554 Pt-1 / IS 8130 & Approved Data Sheet	IS 1554 Pt-1 / IS 8130 & Approved Data Sheet	Log Book	2	-	-		
		3. Sequence, lay length & Direction	MA	Visual, Measurement	Sample	IS 1554 Pt-1/ Mfrs standard	IS 1554 Pt-1/ Mfrs standard	Log Book	2	-	-		
		4. Surface Finish	MA	Visual	100%	Surface shall be smooth	Surface shall be smooth	Log Book	2	-	-		
		5. Dimension	MA	Measurement	One Sample of each size/ lot	IS 1554 Pt-1/ IS 8130/ Appd. Data Sheet	IS 1554 Pt-1/ IS 8130/ Appd. Data Sheet	Log Book	2	-	-		
2.4	Core Insulation (No repair permitted)	1. Surface finish	MA	Visual	100%	Free from bulging burnt particles lumps, cuts & Scratches.	Free from bulging burnt particles lumps, cuts & Scratches.	Log Book	2	-	1		
		2. Insulation thickness	CR	Measurement	One Sample of each size/ lot	IS 1554 Pt-1 & Appd. data sheet	IS 1554 Pt-1 & Appd. data sheet	Log Book	2	-	-		
		3. Concentricity #	CR	Measurement	One Sample of each size/ lot	Mfrs Std/ IS 1554 Pt-1/ Approved Data Sheet	Mfrs Std/ IS 1554 Pt-1/ Approved Data Sheet	Log Book	2	-	1		# To be checked at starting & finish end of Extruded Length
		4. Dia over insulation	MA	Measurement	One Sample of each size/ lot	IS 1554 Pt-1	IS 1554 Pt-1	Log Book	2	-	-		
		5. Core identification	MA	Visual	100%	IS 1554 Pt-1 & Appd. Data Sheet	IS 1554 Pt-1 & Appd. Data Sheet	Log Book	2	-	-		
		6. Tensile Strength & % Elongation	MA	Mechanical	100%	IS 1554 Pt-1/ IS 5831	IS 1554 Pt-1/ IS 5831	Log Book	2	-	-		
		7. Spark Test or Water Immersion test	CR	Electrical	100%	Mfr's Std.	Mfr's Std.	Log Book	2	-	1		
2.5	Core Laying	1. Dia over laidup core	MA	Measurement	One Sample of each size/ lot	IS 1554 Pt-1	IS 1554 Pt-1	Log Book	2	-	-		
		2. Sequence of lay, Lay length & direction for laid up core	MA	Visual & Meas.	One Sample of each size/ lot	Mfrs Std	Mfrs Std	Log Book	2	-	-		
		3. Core Identification	MA	Visual	One Sample of each size/ lot	IS 1554 Pt-1 & Appd. Data Sheet	IS 1554 Pt-1 & Appd. Data Sheet	Log Book	2	-	-		
BHEL			PARTICULARS		BIDDER/VENDOR								
			NAME										
			SIGNATURE										
			DATE					BIDDER'S/VENDORS COMPANY SEAL					

		QUALITY PLAN SHEET 4 OF 8		CUSTOMER :		PROJECT			SPECIFICATION :			
				BIDDER/ VENDOR		TITLE			NUMBER : PE-TS-XXX-507-E003			
				SYSTEM		QUALITY PLAN NUMBER PE-QP-999-507-E003, R-0			SPECIFICATION : TITLE			
SL. NO.	COMPONENT/OPERATION	CHARACTERISTICS CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	SECTION AGENCY VOLUME III			
1	2	3	4	5	6	7	8	9	10	P	W	V
2.6	InnerSheath Extrusion (If applicable)	1. Surface finish	MA	Visual	100%	Surface shall be Smooth	Surface shall be Smooth	Log Book	2	-	-	(Pimple, fish eye, porosity & burnt particles not permitted)
		2. Sheath thickness	CR	Measurement	One Sample of each size/ lot	IS 1554 Pt-1 & Approved Data Sheet	IS 1554 Pt-1 & Approved Data Sheet	Log Book	2	-	-	
		3. Dia over inner sheath	MA	Measurement	One Sample of each size/ lot	IS 1554 Pt-1 & Approved Data Sheet	IS 1554 Pt-1 & Approved Data Sheet	Log Book	2	-	-	
2.7	Armouring (If applicable)	1. No. of wires/Strips	MA	Counting	At the start of the process	IS 1554 Pt-1/ IS 3975	IS 1554 Pt-1/ IS 3975	Log Book	2	-	-	
		2. Lay Direction	MA	Visual	At the start of the process	IS 1554 Pt-1/ IS 3975	IS 1554 Pt-1/ IS 3975	Log Book	2	-	-	
		3. Lay Length	MA	Visual, Meas.	At the start of the process	IS 1554 Pt-1/ IS 3975	IS 1554 Pt-1/ IS 3975	Log Book	2	-	-	
		4. Coverage	MA	Measurement	At the start of the process	IS 1554 Pt-1/ IS 3975 & approved data sheet	IS 1554 Pt-1/ IS 3975 & approved data sheet	Log Book	2	-	-	
		5. Dia over armouring	MA	Measurement	At the start of the process	IS 1554 Pt-1 & Appd. Data Sheet	IS 1554 Pt-1 & Appd. Data Sheet	Log Book	2	-	-	
2.7	Outer Sheath Extrusion	1. Surface Finish	MA	Visual	100%	Surface shall be smooth	Surface shall be smooth	Log Book	2	-	-	(Pimple, fish eye, porosity & burnt particles not permitted)
		2. Sheath thickness	CR	Measurement	One Sample of each size/ lot	IS 1554 Pt-1 & Appd. Data Sheet	IS 1554 Pt-1 & Appd. Data Sheet	Log Book	2	-	-	
		3. Dia over outer sheath	MA	Measurement	One Sample of each size/ lot	IS 1554 Pt-1 & Appd. Data Sheet	IS 1554 Pt-1 & Appd. Data Sheet	Log Book	2	-	-	
		4. Marking/ Color/ Embossing	MA	Visual	One Sample of each size/ lot	Appd. Data Sheet	Appd. Data Sheet	Log Book	2	-	-	
2.8	Finished Cable (INTERNAL)	1. Routine Test (Refer Note-H)	CR	Electrical Tests & Measurement	100%	IS 1554-I & Appd. Datasheet	IS 1554-I & Appd. Datasheet	Test Report	2	-	1	Sequential marking shall be done by printing.
BHEL			PARTICULARS		BIDDER/VENDOR							
			NAME									
			SIGNATURE									
			DATE					BIDDER'S/VENDORS COMPANY SEAL				

		QUALITY PLAN		CUSTOMER :		PROJECT TITLE		SPECIFICATION : NUMBER : PE-TS-XXX-507-E003				
				BIDDER/ VENDOR		QUALITY PLAN NUMBER PE-QP-999-507-E003, R-0		SPECIFICATION : TITLE				
SHEET 5 OF 8		SYSTEM		ITEM : HRPVC/ PVC POWER & CONTROL CABLE		SECTION		VOLUME III				
SL. NO.	COMPONENT/OPERATION	CHARACTERISTICS CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
1	2	3	4	5	6	7	8	9	P	W	V	11
3.0	Final Inspection	1. Finish	MA	Visual	(See remark)	IS 1554 Pt-1/ Appd. Data Sheet	Free from Porosity, Bulging, Burnt particles, lumps, cuts & scratches	Test Report	2	1	-	One drum each for Power & Control cables in Lot.
		2. Length	MA	Measurement	(See remark)	IS 1554 Pt-1/ Appd. Data Sheet	BHEL Spec./ Data Sheet	Test Report	2	1		Length of each drum shall be as per tolerance given in the data sheet.
		3. Dimension	MA	Measurement	As per IS	IS 1554 Pt-1/ Appd. Data Sheet	Approved Data Sheet	Test Report	2	1	-	
		4. Armouring - Coverage No. of Wires/Strips	MA	Visual & Meas.	As per IS	IS 1554 Pt-1/ Appd. Data Sheet	Appd. Data Sheet	Test Report	2	1	-	
		4. Marking/Colour Coding	MA	Visual	As per IS	IS 1554 Pt-1/ Appd. Data Sheet	IS 1554 Pt-1/ Appd. Data Sheet	Test Report	2	1	-	
		5. Acceptance Tests (Refer Note-H)	CR	Phy & Elect. Tests FRLS tests	As per IS	IS 1554 Pt-1/ Appd. Data Sheet	IS 1554 Pt-1/ Appd. Data Sheet	Test Report	2	1		
		6. Type & FRLS Tests (Refer Note-H)	CR	Phy & Elect. Tests FRLS Tests	Sample#	BHEL Specn. Apprd. Data Sheet	BHEL Specn. Apprd. Data Sheet	Test Report	2	1	-	Refer Annexure to QAP for Type & Acceptance Tests
4.0	Packing	Sealing Identification	MA	Visual	100%	As per IS	As per IS	Test Report	2	1	-	
NOTES:- (A) JOINTS IN WIRE SHALL BE AS PERMITTED BY MFRS STANDARD. VENDOR TO CERTIFY THE SAME. (B) NO REPAIR OF CORE INSULATION PERMITTED (C) CABLE ENDS SHALL BE SEALED AS PER VENDOR'S SPECIFICATION. (D) RECORD OF RAW MATERIAL, PROCESS & ALL STAGES SHALL BE CERTIFIED BY VENDORS QC. AND ARE LIABLE TO AUDIT CHECK BY PURCHASER. (E) FILLERS/DUMMY CORES ETC. SHALL BE AS PER APPROVED DATA SHEET (F) WHEREVER EXTENT OF CHECK FOR STAGE IS MENTIONED AS 'SAMPLE' & NOT DEFINED IN QP, THE SAME SHALL BE AS PER VENDORS SAMPLING PLAN. (G) VENDOR SHALL FURNISH COMPLIANCE CERTIFICATE TO THE INSPECTION AGENCY CONFIRMING THE PACKING AS PER IS/ BHEL SPECIFICATION. (H) FOR LISTS OF ROUTINE TESTS, ACCEPTANCE TESTS & TYPE TESTS REFER ANNEXURE TO QAP.												
LEGEND : P : PERFORMER W: WITNESSER V: VERIFIER 1- BHEL 2-VENDOR 3- SUB VENDOR CHP: CUSTOMER HOLD POINT WHICH WILL BE DECIDED AT CONTRACT STAGE.												
BHEL			PARTICULARS		BIDDER/VENDOR		BIDDER'S/VENDORS COMPANY SEAL					
			NAME									
			SIGNATURE									
			DATE									

	ANNEXURE TO QAP	CUSTOMER:	PROJECT TITLE:	SPECIFICATION NUMBER:
		BIDDER/VENDOR:	QUALITY PLAN NUMBER : PE-QP-999-507-E003, R0	SPECIFICATION TITLE:
	SHEET 6 OF 8	SYSTEM	ITEM: HRPVC/ PVC POWER & CONTROL CABLE	DOC. NO.

TYPE/ ACCEPTANCE/ ROUTINE TEST REQUIREMENTS

A. Type Test Conduction:

- Tests for which "T" is indicated in the 'Test Conduction Required As' column below shall be conducted as Type Test.
- Sampling:
 - Type test shall be conducted & witnessed on one size (sample) of every lot of control cable.
 - Type test shall be conducted & witnessed on one size (sample) per type (Cu/ Al conductor) of every lot for power cable.
 - Flammability Test to be conducted only on one sample/ lot.

B. Acceptance Test Conduction:

- Tests for which "A" is indicated in the 'Test Conduction Required As' column below shall be conducted as Acceptance tests.
- Sampling:
 - Sampling for acceptance tests shall be as per Appendix-B of IS: 1554 Part-I.
 - Flammability Test to be conducted only on one sample/ lot.

C. Routine Test Conduction:

- Tests for which "R" is indicated in the 'Test Conduction Required As' column below shall be conducted as Routine tests.
- Tests listed in S.No-7.0 & 8.0 shall be conducted only on one size (sample) of every lot.

S. No.	TEST	APPLICABLE FOR	TEST CONDUCTION REQUIRED AS	REFERENCE STANDARD	REMARKS
1.0	Tests for Conductor				
I.	Annealing test	For copper conductor	T, A	IS 10810 Pt 1	<i>In process records shall be furnished to inspector at the time of inspection.</i>
II.	Tensile Test	For aluminium conductor	T, A	IS 10810 Pt 2	
III.	Wrapping test	For aluminium conductor	T, A	IS 10810 Pt 3	
IV.	Resistance test	For copper/ aluminium conductor	T, A, R	IS 10810 Pt 5	
2.0	Tests for Round Steel Wires/Strips				
I.	Measurement of dimensions	For GS Round wire/Strip	T, A	IS 10810 Pt 36	
II.	Tensile test	For GS Round wire/Strip	T, A	IS 10810 Pt 37	
III.	Elongation test	For GS Round wire/Strip	T, A	IS 10810 Pt 37	
IV.	Torsion test	For GS Round wire	T, A	IS 10810 Pt 38	

BHEL	PARTICULARS	BIDDER/ VENDOR	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S / VENDORS COMPANY SEAL

	ANNEXURE TO QAP	CUSTOMER:	PROJECT TITLE:	SPECIFICATION NUMBER:
		BIDDER/VENDOR:	QUALITY PLAN NUMBER : PE-QP-999-507-E003, R0	SPECIFICATION TITLE:
	SHEET 7 OF 8	SYSTEM	ITEM: HRPVC/ PVC POWER & CONTROL CABLE	DOC. NO.

S. No.	TEST	APPLICABLE FOR	TEST CONDUCTION REQUIRED AS	REFERENCE STANDARD	REMARKS
V.	Winding test	For GS Formed wire	T, A	IS 10810 Pt 39	
VI.	Resistivity test	For GS wire/Strip	T, A	IS 10810 Pt 42	
VII.	Uniformity of Zinc coating test	For G. S. wires/Strip	T, A	IS 10810 Pt 40	
VIII.	Mass of Zinc coating test	For G. S. wires/Strip	T, A	IS 10810 Pt 41	
3.0	Physical Tests for PVC Insulation & PVC sheath				
I.	Test for thickness	Applicable for PVC insulation, PVC inner sheath & PVC outer sheath	T, A	IS 10810 Pt 6	
II.	Tensile strength and elongation test at break	Applicable for PVC insulation & PVC outer sheath	T, A	IS 10810 Pt 7	
III.	Ageing in air oven	Applicable for PVC insulation & PVC outer sheath	T	IS 10810 Pt 11	
IV.	Loss of mass in air oven test	Applicable for PVC insulation & PVC outer sheath	T	IS 10810 Pt 10	
V.	Hot deformation test	Applicable for PVC insulation & PVC outer sheath	T	IS 10810 Pt 15	
VI.	Heat shock test	Applicable for PVC insulation & PVC outer sheath	T	IS 10810 Pt 14	
VII.	Shrinkage test	For PVC insulation & PVC outer sheath only	T	IS 10810 Pt 12	
VIII.	Thermal stability test	Applicable for PVC insulation & PVC outer sheath	T	IS 10810 Pt 60	
4.0	Improved Fire performance (FR-LSH) Tests				
I.	Oxygen index test	For PVC outer sheath only ^(S)	T, A	ASTMD 2863	
II.	Smoke density test	For PVC outer sheath only ^(S)	T, A	ASTM D2843	
III.	Acid gas generation test	For PVC outer sheath only ^(S)	T, A	IEC-754-1	
IV.	Temperature Index Test	For PVC outer sheath only ^(S)	T	ASTMD 2863	
5.0	Flammability Tests				
I.	Flammability test for single cable	For complete cable	T, A	IS: 1554 Part-I (As per category C2)/ IEC-60332 (Part-1)	Project Specific (As indicated in Datasheet-A)
II.	Flammability test for bunched cables	For complete cable	T	IS: 1554 Part-1 (As per category C2)/ IEC-60332 Part-3-23, Category-B / Category-A	
III.	Swedish chimney test	For complete cable	A	SEN SS 424 1475	

BHEL	PARTICULARS	BIDDER/ VENDOR	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S / VENDORS COMPANY SEAL

	ANNEXURE TO QAP	CUSTOMER:	PROJECT TITLE:	SPECIFICATION NUMBER:
		BIDDER/VENDOR:	QUALITY PLAN NUMBER : PE-QP-999-507-E003, R0	SPECIFICATION TITLE:
	SHEET 8 OF 8	SYSTEM	ITEM: HRPVC/ PVC POWER & CONTROL CABLE	DOC. NO.

S. No.	TEST	APPLICABLE FOR	TEST CONDUCTION REQUIRED AS	REFERENCE STANDARD	REMARKS
IV.	Flammability test	For complete cable	A	IEEE:383	
6.0	Electrical Tests				
I.	High Voltage Test (Water Immersion test)	On Cores	T	IS 10810 Pt 45	
II.	High Voltage Test at Room Temperature	For complete cable	T, A, R	IS 10810 Pt 45	
III.	Insulation Resistance Test (Volume resistivity method)	For complete cable	T, A	IS 10810 Pt 43	
7.0	Anti-Rodent and Termite Repulsion test	For PVC outer sheath only	A	--	Project Specific (As indicated in Datasheet-A)
8.0	Anti Fungal Test	For PVC outer sheath only	A	--	Project Specific (As indicated in Datasheet-A)
9.0	Special Tests^(*)				
I.	Hydrolytic Stability	For complete cable	**	ASTM D 3137:81	Project Specific (As indicated in Datasheet-A)
II.	Ultraviolet Test	For complete cable	**	BS EN ISO 4892	

\$:- If inner sheath is also FRLS, then these tests will be applicable for inner sheath as well.

**** These tests shall be conducted on one sample for the entire contract and duration of these tests shall be 14 days.**

BHEL	PARTICULARS	BIDDER/ VENDOR	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S / VENDORS COMPANY SEAL

		QUALITY PLAN		CUSTOMER :		PROJECT		SPECIFICATION :				
				TITLE		NUMBER :						
SHEET 1 OF 5		BIDDER/ VENDOR		QUALITY PLAN		SPECIFICATION		TITLE				
SYSTEM		ITEM : INSTRUMENTATION CABLES		NUMBER: PE-QP-999-507-E004, REV 0.		VOLUME III		REMARKS				
SL. NO.	COMPONENT/OPERATION	CHARACTERISTICS CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY	P	W	V
1	2	3	4	5	6	7	8	9	10	11		

Instructions:

1. Cable manufacturer to maintain records to show co-relation of raw materials to finished cables i.e. raw material batch/ lot no. should be traceable to the final cable drum number or batch no.

2. Cable manufacturer to maintain all quality records identified as per all QP stages enumerated below whether it is identified for BHEL verification or witness or not.

1.0	RAW MATERIAL											
1.1	Copper Rods/ Wires (For Conductor & drain wire)	GENERAL : 1. Physical properties 2. Elec.Properties SPECIFIC CHECKS : a) Make b) Grade c) Resistivity	MA	Physical Tests	Sample	Relevant Standard/ Approved datasheet	Relevant Standard/ Approved datasheet	Log book/ Test Cert.	3/2	-	1/2	
			MA	Electrical Tests	Sample	-do-	-do-	-do-	3/2	-	1/2	
			MA	Verify	100%	Manufacturer approved source	Manufacturer approved source	Log book/ Test Cert.	3/2	-	1	
			MA	-do-	-do-	IS 613/ Approved datasheet	IS 613/ Approved datasheet	-do-	3/2	-	1	
			MA	Electrical Tests	Manufacturer std.	IS 613	IS 613	-do-	3/2	-	1	
1.2	PVC Compound (for insulation)	GENERAL : 1. Physical properties 2. Elec.Properties SPECIFIC CHECKS : a) Make b) Type/ Grade c) Shelf life/ Storage condition	MA	Physical Tests	Sample	Relevant Standard/ Approved datasheet	Relevant Standard/ Approved datasheet	Log book/ Test Cert.	3/2	-	1/2	
			MA	Electrical Tests	Sample	-do-	-do-	-do-	3/2	-	1/2	
			MA	Verify	100%	Manufacturer approved source	Manufacturer approved source	Log book/ Test Cert.	3/2	-	1	
			MA	-do-	-do-	Approved datasheet	Approved datasheet	-do-	3/2	-	1	
			MA	-do-	-do-	Compound Manufacturer std.	Compound Manufacturer std.	-do-	3/2	-	1	
1.3	Screen / Tapes/ Binders	1. Make 2. Dimension 3. T.S. & Elongation 4. Chem. & Phys. Properties	MA	Verify	100%	Manufacturer approved source	Manufacturer approved source	TC & IR	3/2	-	1/2	
			MA	Measurement	Manufacturer std.	Manufacturer datasheet/ Approved datasheet	Manufacturer datasheet/ Approved datasheet	TC & IR	3/2	-	1/2	
			MA	Physical Tests	-do-	Manufacturer datasheet	Manufacturer datasheet	-do-	3/2	-	1/2	
			MA	Chemical & Physical Tests	-do-	Manufacturer std.	Manufacturer std.	-do-	3/2	-	1/2	

BHEL	PARTICULARS	BIDDER/VENDOR
	NAME	
	SIGNATURE	
	DATE	
	CUSTOMER :	PROJECT
		BIDDER'S/VENDORS COMPANY SEAL
		SPECIFICATION :

						TITLE			NUMBER :				
		QUALITY PLAN		BIDDER/ VENDOR :		QUALITY PLAN			SPECIFICATION :				
		SHEET 2 OF 5		SYSTEM		NUMBER: PE-QP-999-507-E004, REV 0.			TITLE				
						ITEM : INSTRUMENTATION CABLES			SECTION		VOLUME III		
SL. NO.	COMPONENT/OPERATION	CHARACTERISTICS CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY	P	W	V	REMARKS
1	2	3	4	5	6	7	8	9	10				11
1.4	Fillers (as applicable)	1. Type 2. Flame retardant & moisture resistant. (as applicable)	MA CR	Verify Chemical/ Environ.	-do- -do-	Approved datasheet -do-	Approved datasheet -do-	-do- -do-	3/2 3/2	- -	1 2		
1.5	Galvanised steel wire/strip for Armour (if applicable)	GENERAL : 1. Make	MA	Verify	Manufacturer std.	Manufacturer approved source	Manufacturer approved source	Log book/ Test Cert.	3/2	-	1		
		2. Dimension	MA	Measurement	-do-	-do-	-do-	-do-	3/2	-	2		
		3. Phy.and Elec. Properties	MA	Physical & Electrical Tests	Sample*	Relevant Standard/ Appd. Data Sheet/	Relevant Standard/ Appd. Data Sheet/	-do-	3/2	-	2		* Sample from each size/ Batch/Lot.
		3. Galvanization Quality	MA	Galv. Tests	-do-	-do-	-do-	-do-	3/2	-	2		
1.6	PVC compound for Sheath	GENERAL : 1. Physical properties	MA	Physical Tests	Sample	Relevant Standard/ Approved datasheet	Relevant Standard/ Approved datasheet	Log book/ Test Cert.	3/2	-	1/2		
		2. Elec.Properties	MA	Electrical Tests	Sample	-do-	-do-	-do-	3/2	-	1/2		
		3. FRLS Properties (as applicable)	CR	Chemical/ Environ.	Sample	-do-	-do-	-do-	3/2	-	1/2		
		SPECIFIC CHECKS : a) Make	MA	Verify	100%	Manufacturer approved source	Manufacturer approved source	Log book/ Test Cert.	3/2	-	1		
		b) Type/ Grade	MA	-do-	-do-	Approved datasheet	Approved datasheet	-do-	3/2	-	1		
		c) Shelf life/ Storage condition	MA	-do-	-do-	Compound Manufacturer std.	Compound Manufacturer std.	-do-	3/2	-	1		
1.7	Wooden drums	1. Phy. & Constructional checks 2. Anti termite treatment	MA MA	Visual Chem.	Mfr's Plant Std. Mfr's Plant Std.	IS 10418 Mfr's Plant Std.	IS 10418 Mfr's Plant Std.	Log book/ Test Cert. COC	3/2 3/2	- -	1 1		
1.8	Steel drums	1. Dimension 2. Surface finish	MA MA	Meas. Meas.	Mfr's Plant Std. -do-	Mfr's Plant Std. -do-	Mfr's Plant Std. -do-	Log book/ Test Cert. -do-	3/2 3/2	- -	1 1		
2.0 IN PROCESS													
2.1	Wire Drawing & Annealing.	1. Size 2. Surface finish 3. % of Elongation	MA MA MA	Dimensional Visual Mechanical	Plant Mfg. Std. -do- -do-	Approved datasheet Surface shall be smooth IS 8130	Approved datasheet Surface shall be smooth IS 8130	Log Book	2	-	1		
2.2	Tinning (Conductor or drain wire)	1. Size 2. % of Elongation	MA MA	Dimensional Mechanical	Plant Mfg. Std. -do-	Approved datasheet IS 8130	Approved datasheet IS 8130	Log Book	2	-	1		(Applicable only for tin-coated copper conductor and drain wire)
2.3	Stranding of wires	1. No. of wires	MA	Counting	Plant Mfg. Std.	IS 8130/ Appd. Data Sheet	IS 8130/ Appd. Data Sheet	-do-	2	-	-		
			PARTICULARS		BIDDER/VENDOR								
BHEL			NAME										
			SIGNATURE										
			DATE										
													BIDDER'S/VENDORS COMPANY SEAL

		QUALITY PLAN SHEET 3 OF 5		CUSTOMER :		PROJECT TITLE		SPECIFICATION : NUMBER :			
				BIDDER/ :		QUALITY PLAN NUMBER: PE-QP-999-507-E004, REV 0.		SPECIFICATION : TITLE			
				VENDOR		ITEM :INSTRUMENTATION CABLES		SECTION VOLUME III			
SL. NO.	COMPONENT/OPERATION	CHARACTERISTICS CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY	REMARKS	
1	2	3	4	5	6	7	8	9	10	11	
2.4	Core Insulation (No repair permitted)	2. Resistance	CR	Electrical	-do-	-do-	-do-	-do-	2	-	-
		3. Sequence, lay length & Direction	MA	Visual, Meas	Sample	BHEL'S/ Vendor's Spec./ Approved datasheet	BHEL'S/ Vendor's Spec./ Approved datasheet	-do-	2	-	-
		4. Surface Finish	MA	Visual	Sample	-do-	-do-	-do-	2	-	-
		5.Dimension	MA	Measurement	Sample	Appd. Data Sheet	Appd. Data Sheet	-do-	2	-	-
		1. Surface finish	MA	Visual	100%	-	Free from bulging burnt particles lumps, cuts & Scratches.	-do-	2	-	1
		2 Insulation thickness (Min./ Max.)	CR	Measurement	Sample	Appd.data sheet/ Relevant Std.	Appd.data sheet/ Relevant Std.	-do-	2	-	-
		3. Concentricity #	CR	Measurement	Sample	Mfr's Std./Appd. data sheet	Mfr's Std./Appd. data sheet	Log Book	2	-	1
		4 Dia over insulation	MA	Measurement	Sample	Relevant Standard/ Appd. Data Sheet	Relevant Standard/ Appd. Data Sheet	-do-	2	-	-
2.5	Core pairing, screening (provision of drain wire & laying)	5. Core identification	MA	Visual	100%	Relevant Standard/ Appd. Data Sheet	Relevant Standard/ Appd. Data Sheet	-do-	2	-	-
		6. TS & % Elongation	MA	Mechanical	100%	Relevant Standard/ Appd. Data Sheet	Relevant Standard/ Appd. Data Sheet	-do-	2	-	-
		1. Pair identification	MA	Visual	100%	Relevant Standard/ Appd. Data Sheet	Relevant Standard/ Appd. Data Sheet	Log Book	2	-	-
		2.Wire size & tape size	MA	Measurement	100%	-do-	-do-	-do-	2	-	-
		3.Test for capacitance	CR	Elect. Test	100%	-do-	-do-	-do-	2	-	1
		4. Sequence of lay and lay length	MA	Visual meas	Sample	Appd. Data Sheet & MFRs. Std.	Appd. Data Sheet & MFRs. Std.	-do-	2	-	-
		5. Screen overlap & coverage	MA	Measurement	Sample	-do-	-do-	-do-	2	-	-
		6. Dia over laid up core	MA	Measurement	-do-	-do-	-do-	-do-	2	-	-
		7. Continuity of drain & drain wire with Screen	MA	Elect. Test	100%	<-----No Discontinuity ----->	-do-	2	-	-	
			PARTICULARS		BIDDER/VENDOR						
BHEL			NAME								
			SIGNATURE								
			DATE				BIDDER'S/VENDORS COMPANY SEAL				

	QUALITY PLAN		CUSTOMER :			PROJECT TITLE			SPECIFICATION : NUMBER :				
			BIDDER/ : VENDOR			QUALITY PLAN NUMBER: PE-QP-999-507-E004, REV 0.			SPECIFICATION : TITLE				
	SHEET 4 OF 5			SYSTEM			ITEM :INSTRUMENTATION CABLES			SECTION VOLUME III			
SL. NO.	COMPONENT/OPERATION	CHARACTERISTICS CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS	
1	2	3	4	5	6	7	8	9	10	P	W	V	11
2.6	Inner Sheath Extrusion (if applicable)	1. Surface finish	MA	Visual	100%	--	Free from bulging, burnt particles,lumps cuts & scratches.	-do-	2	-	-		
		2. Sheath thickness	MA	Measurement	Sample			-do-	2	-	-		
		3.Dia over inner sheath	MA	Measurement	Sample	Relevant Standard/ Appd. Data Sheet	Relevant Standard/ Appd. Data Sheet	-do-	2	-	-		
		4. Colour	MA	Visual	100%	Relevant Standard/ Appd. Data Sheet	Relevant Standard/ Appd. Data Sheet	-do-	2	-	-		
2.7	Armouring (If Applicable)	1. No.of wires/Strips	MA	Counting	At the start of the process	Relevant Standard/ Appd. Data Sheet	Relevant Standard/ Appd. Data Sheet	-do-	2	-	-		
		2. Size of wire/ Strip	MA	Measurement	-do-	-do-	-do-	-do-	2	-	-		
		3. Lay Direction	MA	Visual	-do-	-do-	-do-	-do-	2	-	-		
		4. Lay Length	MA	Visual, Meas.	At the start of the process	Relevant Standard/ Appd. Data Sheet	Relevant Standard/ Appd. Data Sheet	Log Book	2	-	-		
		5. Coverage	MA	Measurement	-do-	Relevant Standard/ Appd. Data Sheet	Relevant Standard/ Appd. Data Sheet	-do-	2	-	-		
		6. Dia over armouring	MA	Measurement	-do-	-do-	-do-	-do-	2	-	-		
2.8	Outer Sheath Extrusion	1. Surface Finish	MA	Visual	100%	-	Free from Bulging Burnt particles, lumps, cuts & scratches	Log Book	2	-	-		
		2.Sheath thickness	MA	Measurement	Sample	Relevant Standard/ Appd. Data Sheet	Relevant Standard/ Appd. Data Sheet	Log Book	2	-	-		
		3. Dia over outer sheath	MA	Measurement	Sample	-do-	-do-	-do-	2	-	-		
BHEL			PARTICULARS			BIDDER/VENDOR							
			NAME										
			SIGNATURE										
			DATE						BIDDER'S/VENDORS COMPANY SEAL				

		QUALITY PLAN		CUSTOMER :		PROJECT TITLE			SPECIFICATION : NUMBER :				
				BIDDER/ VENDOR		QUALITY PLAN NUMBER: PE-QP-999-507-E004, REV 0.			SPECIFICATION : TITLE				
SHEET 5 OF 5		SYSTEM		ITEM : INSTRUMENTATION CABLES			SECTION		VOLUME III				
SL. NO.	COMPONENT/OPERATION	CHARACTERISTICS CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY	P	W	V	REMARKS
1	2	3	4	5	6	7	8	9	10				11
3.0	Final Inspection	4. Marking/ Colour/ Embossing 5. TS & % Elongation 1. Finish & Length 2. Dimensions 3. Armouring - Coverage No. of Wires/Strips 4. Marking/Colour/ pair identification 5. Test for screening 6. Acceptance Tests 7. Type & FRLS Tests	MA	Visual	100%	Appd. Data Sheet	Appd. Data Sheet	Test Report	2	-	-		Sequential marking shall be done by printing
			MA	Mechanical	100%	Relevant Standard/ Appd. Data Sheet	Relevant Standard/ Appd. Data Sheet	-do-	2	-			
			MA	Visual	(See remark)	Relevant Standard/ Appd. Data Sheet	Free from Bulging Burnt particles, lumps, cuts & scratches	Test Report	2	1	-		One drum in a Lot
			MA	Measurement	Sample Lengths	Appd. Data sheet	Appd. Data sheet	Test Report	2	1	-		
			MA	Visual & Meas.	Sample	-do-	-do-	-do-	2	1	-		
			MA	Visual	-do-	-do-	-do-	-do-	2	1	-		
			CR	Elect. Test	-do-	-do-	-do-	-do-	2	1	-		
			CR	Phy & Elect. Tests	sample	-do-	-do-	-do-	2	1			Refer Annexure to QAP for sampling plan.
			CR	Measurement	Sample#	Appd. Data sheet	Appd. Data sheet	-do-	2	1	-		Refer Annexure to QAP for sampling plan.
NOTES:- (A) JOINTS IN WIRE SHALL BE AS PERMITTED BY REL STD / BHEL SPECIFICATION. VENDOR TO CERTIFY THE SAME. (B) NO REPAIR OF CORE INSULATION PERMITTED (C) CABLE ENDS SHALL BE SEALED AS PER REL. STD. / BHEL SPECIFICATION (D) RECORD OF RAW MATERIAL, PROCESS & ALL STAGES SHALL BE CERTIFIED BY VENDORS QC. AND ARE LIABLE TO AUDIT CHECK BY PURCHASER. (E) FILLERS/DUMMY CORES ETC. SHALL BE AS PER BHEL SPECIFICATION (F) WHEREVER EXTENT OF CHECK FOR STAGE IS MENTIONED AS SAMPLES AND NOT DEFINED IN QP, THE SAME SHALL BE AS PER VENDORS SAMPLING PLAN AGREED BY PURCHASER. (G) VENDOR SHALL FURNISH COMPLIANCE CERTIFICATE TO THE INSPECTION AGENCY CONFIRMING THE PACKING AS PER REL. STD. / BHEL SPECIFICATION. (H) FOR LIST OF TYPE TESTS, ROUTINE TESTS & ACCEPTANCE TESTS; REFER ANNEXURE TO QAP.													
LEGEND : P : PERFORMER W: WITNESSER V: VERIFIER 1- BHEL/CUSTOMER 2-VENDOR 3 SUB VENDOR CHP: CUSTOMER HOLD POINT TC : Test Certificates, Spec. : Specification Mfg. : Manufacturer.													
BHEL			PARTICULARS			BIDDER/VENDOR							
			NAME										
			SIGNATURE										
			DATE										
													BIDDER'S/VENDORS COMPANY SEAL

	ANNEXURE TO QAP	CUSTOMER:	PROJECT TITLE:	SPECIFICATION NUMBER:
		BIDDER/VENDOR:	QUALITY PLAN NUMBER : PE-QP-999-507-E004, R0	SPECIFICATION TITLE:
	SHEET	SYSTEM	ITEM: SCREENED CONTROL CABLES (AS PER IS)	DOC. NO.

TYPE/ ACCEPTANCE/ ROUTINE TEST REQUIREMENTS (AS PER IS)

A. Type Test Conduction:

- Tests for which "T" is indicated in the 'Test Conduction Required As' column below shall be conducted as Type Test.
- Sampling:
 - Type test to be conducted on one size of each type/ lot.
 - FRLS test & Electrical tests to be conducted on every size & type of cables.
 - Flammability Test to be conducted only on one sample/ lot.

B. Acceptance Test Conduction:

- Tests for which "A" is indicated in the 'Test Conduction Required As' column below shall be conducted as Acceptance tests.
- Sampling:
Sampling for acceptance tests shall be as per Appendix-B (Clause 15.2.2) of IS: 1554 Part-I.

C. Routine Test Conduction:

- Tests for which "R" is indicated in the 'Test Conduction Required As' column below shall be conducted as Routine tests.

- D. C&I Tests listed in S.No-9.0 shall be conducted only one size/ type / lot.
 E. Tests listed in S.No-10.0 & 11.0 shall be conducted only on one sample / lot.
 F. ADS: Approved datasheet.

S. No.	TEST	APPLICABLE FOR	TEST CONDUCTION REQUIRED AS	REFERENCE STANDARD	REMARKS
1.0	Tests for Conductor				
I.	Annealing test	For copper conductor only	T, A	IS 10810 Pt 1	<i>Internal in process Test Report to be furnished for acceptance test</i>
II.	Tin coating test (for tinned copper)	For copper conductor only	T, A	IS 10810 Pt 4	
III.	Resistance test	For Al/Cu	T, A, R	IS 10810 Pt 5	
IV.	Diameter test	For conductor	T, A	ADS	
2.0	Tests for Armour Wires/Strips				
I.	Measurement of dimensions	Applicable for Aluminium wire & GS wire/Strip	T,A	IS 10810 Pt 36	
II.	Tensile test	Applicable for Aluminium wire & GS wire/Strip	T, A	IS 10810 Pt 37	

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	ANNEXURE TO QAP	CUSTOMER:	PROJECT TITLE:	SPECIFICATION NUMBER:
		BIDDER/VENDOR:	QUALITY PLAN NUMBER : PE-QP-999-507-E004, R0	SPECIFICATION TITLE:
	SHEET	SYSTEM	ITEM: SCREENED CONTROL CABLES (AS PER IS)	DOC. NO.

S. No.	TEST	APPLICABLE FOR	TEST CONDUCTION REQUIRED AS	REFERENCE STANDARD	REMARKS
III.	Elongation at break test	Applicable for GS wire/Strip only	T, A	IS 10810 Pt 37	
IV.	Torsion test	For GS round wire only	T, A	IS 10810 Pt 38	
V.	Winding test	For GS strip only	T, A	IS 10810 Pt 39	
VI.	Resistivity test	Applicable for Aluminium wire & GS wire	A	IS 10810 Pt 42	
VII.	Uniformity of Zinc coating test	For G. S. wires/Strip only	A	IS 10810 Pt 40	
VIII.	Mass of Zinc coating test	For G. S. wires/Strip only	A	IS 10810 Pt 41	
IX.	Wrapping Test	For Aluminium wires only	A	IS 10810 Pt 3	
3.0	Physical Tests for PVC Insulation & PVC sheath				
I.	Test for thickness & Eccentricity	Applicable for PVC insulation, PVC inner sheath & PVC outer sheath	T, A	IS 10810 Pt 6	
II.	Tensile strength and elongation test at break	Applicable for PVC insulation & PVC outer sheath	T, A	IS 10810 Pt 6	
(a)	Before ageing		T, A	IS 10810 Pt 7	
(b)	After ageing		T, A	IS 10810 Pt 7	
III.	Ageing in air oven	Applicable for PVC insulation & PVC outer sheath	T	IS 10810 Pt 11	
IV.	Loss of mass in air oven test	For PVC outer sheath only	T	IS 10810 Pt 10	
V.	Hot deformation test	For PVC outer sheath only	T	IS 10810 Pt 15	
VI.	Heat shock test	For PVC outer sheath only	T	IS 10810 Pt 14	
VII.	Shrinkage test	For PVC insulation & PVC outer sheath only	T	IS 10810 Pt 12	
VIII.	Thermal stability test	For PVC outer sheath only	T	IS 10810 Pt 60	
IX.	Hot set test	For PVC insulation only	T, A	IS 10810 Pt 30	
4.0	Tests for Al-Mylar Shield				
I.	Continuity test	For Al-Mylar shield	T, A	Plant Standard	
II.	Shield thickness	For Al-Mylar shield	A	ADS	
III	Overlap test	For Al-Mylar shield	A	ADS	
IV	Constructional details, dimensions	For Al-Mylar shield	A	ADS	
V	Visual, surface finish+	For Al-Mylar shield	A	Plant Standard	
VI	Overall coverage	For Al-Mylar shield	A	Plant Standard	
VII	Noise interference test.	For Al-Mylar shield	A	ADS	
5.0	Tests for Drain Wire				

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		BIDDER/VENDOR:	QUALITY PLAN NUMBER : PE-QP-999-507-E004, R0	SPECIFICATION TITLE:
	SHEET	SYSTEM	ITEM: SCREENED CONTROL CABLES (AS PER IS)	DOC. NO.

S. No.	TEST	APPLICABLE FOR	TEST CONDUCTION REQUIRED AS	REFERENCE STANDARD	REMARKS
I.	Annealing test	For copper conductor only	T, A	IS 10810 Pt 1	<i>Internal in process Test Report to be furnished for acceptance test</i>
II.	Tin coating test (for tinned copper)	For copper conductor only	T, A	IS 10810 Pt 4	
III.	Resistance test	For Al/Cu	T, A, R	IS 10810 Pt 5	
IV.	Diameter test	For conductor	T, A	ADS	
6.0	FRLS Tests				
I.	Oxygen index test	For PVC outer sheath only	T, A	IS 10810 Pt 58 / ASTMD 2863	<u>Applicable for Inner Sheath if the same is indicated in Datasheet-A</u>
II.	Smoke density test	For PVC outer sheath only	T, A	ASTMD 2843	
III.	Acid gas generation test	For PVC outer sheath only	T, A	IS 10810 Pt 59 / IEC-754-1	
IV.	Temperature Index Test	For PVC outer sheath only	T	IS 10810 Pt 64 / ASTMD 2863	
7.0	Flammability Tests				
I.	Flammability test for bunched cables	For complete cable	T,A	IS 10810 Pt 62/ IEC-60332 (Part-3-23, CAT A/ CAT B.	<u>Test & Category applicable as indicated in Datasheet-A</u>
II.	Flammability test for single cable	For complete cable	T,A	IS: 10810 Pt 61 / IEC:60332 Part-1	
III.	Swedish chimney test	For complete cable	A	SEN SS 424 1475 (Class F3)	
IV.	Flammability test	For complete cable	A	IEEE: 60383	
8.0	Electrical Tests				
I.	High Voltage Test	For complete cable	T, A, R	IS 10810 Pt 45	
II.	Insulation Resistance Test (Volume resistivity method)	For complete cable	T, A	IS 10810 Pt 43	
III.	Thermal ageing test	For complete cable	T	IS 1554-I	
9.0	C&I Tests				
I.	Cross talk	For complete cable	T, A	ADS	
II.	Attenuation	For complete cable	T, A	ADS	
III.	Characteristic Impedance	For complete cable	T, A	ADS	
IV.	Mutual capacitance	For complete cable	T, A	ADS	
V.	Noise interference	For complete cable	T, A	ADS	

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	ANNEXURE TO QAP	CUSTOMER:	PROJECT TITLE:	SPECIFICATION NUMBER:
		BIDDER/VENDOR:	QUALITY PLAN NUMBER : PE-QP-999-507-E004, R0	SPECIFICATION TITLE:
	SHEET	SYSTEM	ITEM: SCREENED CONTROL CABLES (AS PER IS)	DOC. NO.

S. No.	TEST	APPLICABLE FOR	TEST CONDUCTION REQUIRED AS	REFERENCE STANDARD	REMARKS
10.0	Anti-rodent and Termite Repulsion test	For PVC outer sheath only	A	--	Test applicable as indicated in Datasheet-A
11.0	Anti-Fungal Test	For PVC outer sheath only	A	--	
12.0	Special Tests				
I.	Hydrolytic Stability	For complete cable	A ^(*)	ASTM D 3137	Test applicable as indicated in Datasheet-A
II.	Ultraviolet Test	For complete cable	A ^(*)	BS EN ISO 4892-2	

**** These tests shall be conducted on one sample for the entire contract and duration of these tests shall be 14 days.**

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	SIGNATURE		
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		QUALITY PLAN		CUSTOMER :		PROJECT TITLE :			SPECIFICATION NO. :			
				BIDDER/ VENDOR :		STANDARD QP NO. : PE-QP-999-507-E005, REV. 0			SPECIFICATION TITLE:			
		SHEET 1 OF 2		SYSTEM CABLING			ITEM : CABLE TRAYS & ACCESSORIES			DOC. NO. :		
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
									P	W	V	
1	2	3	4	5	6	7	8	9	10			11
1.0	RAW MATERIAL											
1.1	ROLLED SHEET	1.CHEM.& PHY. PROPERTIES	MA	VERIFICATION OF TC'S	100%	IS1079	IS1079	MILL TC	3/2	-	1/2	Steel shall be procured from SAIL/TISCO/RINL/BHUSAN/JINDAL STEEL/JINDAL ISPAT/ESSAR/ LLOYD/ IISCO/ authorised SAIL Re Rollers.
		2.DIMENSIONS	MA	MEASUREMENT	100%	IS-1730/ APPD. DATA SHEET IS-1079	IS-1730/ APPD. DATA SHEET IS-1079	QC RECORD	3/2	-	-	
		3.SURFACE FINISH	MA	VISUAL	100%			QC RECORD	3/2	-	-	
1.2	ZINC	CHEM.COMP.	MA	CHEM TEST	EACH HEAT	IS-209	IS-209	QC RECORD	3/2	-	1/2	
2.0	IN-PROCESS											
2.1	FABRICATION	1.DIMENSIONS	MA	MEASUREMENT	100%	APPD.DRG.	APPD.DRG.	QC RECORD	2	-	1	Welding is to be done by qualified welders in accordance with ASME SEC. IX article III. WPS , PQR & WPQ to be reviewed during inspection.
		2.WELDING QUALITY	MA	VISUAL	100%	GOOD WELDING PRACTICE	FREE FROM DEFECTS & SLAG	QC RECORD	2	-	1	
		3.SURFACE FINISH	MA	VISUAL	100%	APPD.DRG.	APPD.DRG.	QC RECORD	2	-	1	
2.2	SURFACE PREPARATION	1.CLEANING PICKLING & RINSING & FLUXING	MA	VISUAL	PERIODIC IN EACH SHIFT	IS:2629	IS:2629	QC RECORD	2	-	-	
		2. SURFACE QUALITY	MA	VISUAL	100%	IS:2629	IS:2629	QC RECORD	2	-	-	
BHEL			PARTICULARS			BIDDER/VENDOR						
			NAME									
			SIGNATURE									
			DATE						BIDDER'S/VENDORS COMPANY SEAL			

LEGEND : 1 - BHEL/ CUSTOMER 2 - VENDOR 3 - SUB- VENDOR P - PERFORM W - WITNESS V - VERIFICATION

		QUALITY PLAN		CUSTOMER :		PROJECT TITLE :			SPECIFICATION NO. :			
				BIDDER/ VENDOR		STANDARD QP NO. : PE-QP-999-507-E005, REV. 0			SPECIFICATION TITLE:			
		SHEET 2 OF 2		SYSTEM CABLING		ITEM : CABLE TRAYS & ACCESSORIES			DOC. NO. :			
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
									P	W	V	
1	2	3	4	5	6	7	8	9	10			11
2.3	GALVANISING	1.TEMPERATURE OF ZINC BATH	MA	TEMPERATURE INDICATOR	CONTINUOUS	IS-2629	IS-2629	QC RECORD	2/3	-	-	If vendor doesn't have his own galvanizing plant duly approved by BHEL PEM; then galvanizing shall be carried out at BHEL-PEM approved other galvanizing plants as per Annexure-2.
		2.DROSS	MA	VISUAL	PERIODIC	IS 2629	IS 2629	QC RECORD	2/3	-	-	
		3.RATE OF IMMERSION	MA	VISUAL	100%	IS 2629/ MFR'S PRACTICE	IS2629/ MFR'S PRACTICE	QC RECORD	2/3	-	2	
		4.SURFACE QUALITY	MA	VISUAL	100%	IS 2629	FREE FROM BURRS ROUGHNESS, SLAG FLUX. STAIN. ETC.	QC RECORD	2/3	-	-	
3.0	FINISHED ITEMS											
3.1	(CABLE TRAY, ACCESSORIES & HARDWARES)	1.DIMENSIONS	MA	MEASUREMENT	IS-2500 (PART 1) LEVEL S-4	APPD. DRG	APPD. DRG	INSP.REPORT	2	1	-	Fasteners shall be of reputed make. Overall thickness of finished product shall not be less than the thickness of cable tray & accessories defined in technical datasheet.
		2.SURFACE FINISH	MA	VISUAL	IS-2500 (PART 1) LEVEL S-4	APPD. DRG	FREE FROM BURRS, SLAG, ROUGHNESS, FLUX. STAIN. ETC.	INSP.REPORT	2	1	-	
		3.RIGIDITY (FOR TRAYS)	MA	DEFLECTION TEST	2 No./ LOT/TYPE	APPD. DRG	APPD. DRG	INSP.REPORT	2	1	-	600MM wide cable tray to be tested. Maximum deflection shall not exceed 7MM on mid span on uniform loading of 100KG/M.
		4.MASS OF ZINC COATING	MA	CHEM. TEST	IS-4759	IS-6745/ APPD. DATASHEET	APPD. DATASHEET	INSP.REPORT	2	1	-	
		5.UNIFORMITY OF ZINC COATING	MA	CHEM. TEST	IS-4759	IS-2633	IS-2633	INSP.REPORT	2	1	-	
		6.THICKNESS OF ZINC COATING	MA	ELCOMETER	IS-4759	APPD. DATASHEET	APPD. DATASHEET	INSP.REPORT	2	1	-	
		7.ADHESION	MA	MECH.TEST	IS-4759	IS-2629	IS-2629	INSP.REPORT	2	1	-	
BHEL			PARTICULARS			BIDDER/VENDOR						
			NAME									
			SIGNATURE									
			DATE						BIDDER'S/VENDORS COMPANY SEAL			

LEGEND : 1 - BHEL/ CUSTOMER 2 - VENDOR 3 - SUB- VENDOR P - PERFORM W - WITNESS V - VERIFICATION