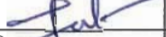




BHARAT HEAVY ELECTRICALS LIMITED

TRANSMISSION PROJECTS ENGINEERING MANAGEMENT

DOCUMENT No.	TB-378-316-034	Rev. No.	00		Prepared	Checked	Approved
TYPE OF DOC.	TECHNICAL SPECIFICATION			NAME	JS	SKS	RS
TITLE 33 KV XLPE POWER CABLE & Accessories				SIGN			
				DATE		06/09/17	01/9
				GROUP	TBEM	W.O. No	
CUSTOMER	TAMILNADU GENERATION AND DISTRIBUTION CORPORATION LIMITED						
PROJECTS	2X660MW ENNORE SEZ SUPERCRITICAL THERMAL POWER PROJECT AT ASH DYKE OF NCTPS. CHENNAI-120						

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Rev No.	Date	Altered	Checked	Approved	REVISION DETAILS				
				Distribution	TBMM	TBQM	TBCM	TBTS	
				Copies	2	-	-	-	

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SECTION - 1

1.1 SCOPE

This technical specification covers the requirements of design, manufacture, testing at works, packing and dispatch of 33 kV XLPE Power Cable and accessories as listed below.

This section covers the scope and quantities of 33 kV XLPE Power cable & cable accessories and services. The Specific Technical Requirements for the above item as specified by the customer is given in Section-2. The offered equipment shall also comply with the General Technical Requirements for the project as detailed under section-3 of this specification.

The specification comprise of following sections:

Section-1: Scope, specific technical requirements & Bill of Quantities.

Section-2A: Equipment specification under scope of supplies.

Section-2B: Accessories specification under scope of supplies.

Section-3: General technical requirements for all equipment's under the project.

Section-4: Equipment Data Sheet

In case of any conflict between various sections, order of precedence shall be in the same order as listed above

The material is required for the following project:

Name of the Customer : Tamilnadu Generation and Distribution Corporation Limited

Name of the Project : 2X660MW ENNORE SEZ SUPERCRITICAL THERMAL POWER PROJECT AT ASH DYKE OF NCTPS. CHENNAI-120

The scope of supplies shall be as per commercial terms and conditions enclosed separately with the enquiry.

1.2 SPECIFIC TECHNICAL REQUIREMENTS

SL.	PARTICULAR	UNIT	DATA
1.	Rated Voltage	kV	19/33 (Earthed)
2.	Type of Insulation		XLPE
3.	Single core / Multi core		Single
4.	Armored /Unarmored		Armored
5.	Material of Conductor		Aluminum
6.	Conductor size	Sqmm	500
7.	Construction Details for 33kV Cable		Please refer Annexure-1
8.	Bonding		Cross bonding
9.	Minimum Continuous Withstand Temperature (For insulation)	Deg C	90
10.	Minimum Short Circuit withstand Temperature (For insulation)	Deg C	250
11.	Creepage Distance	mm / kV	31

1.3 BILL OF QUANTITIES

Please refer attached "Annexure-BOQ"

Note:

(1.) Individual item may vary up-to any extend and even may get deleted, however overall contract value may vary +/- 30%. Variation will be valid up-to contract stage.

(2.) The quantity to be used for type test, special test & acceptance test is not included in the above quantity & shall be in bidder's scope.

(3.) Cable drum length will so finalized to suit cross bonding arrangement i.e. division to circuit length in multiples of three.

(4.) Tentative drum length is 600 meter and the same will be finalized during detailed engineering/contract stage only. Cable lengths shall be considered in such a way that straight through / intermediate cable joints is minimized as per standard practices.

(5.) The cable length per drum shall be subject to a tolerance of $\pm 5\%$ of the standard drum length. The owner shall have the option of rejecting cable drums with shorter lengths. The tolerance allowed on total quantity of each size is $\pm 2\%$.

Tolerance in drum length is to be managed that benefits of cross bonding arrangement is not get affected.

1.4 TESTING

1. **Type test** as per applicable standards as listed in Clause 9.03.00 of Section 2A
2. **Special Test** On HRPVC 'FR-LSH' Material as per applicable standards as listed in Clause 9.04.00 of Section 2A
3. **Routine test** as per applicable standards as listed in Clause 9.05.00 of Section 2A
4. **Acceptance test** as per applicable standards as listed in Clause 9.06.00 of Section 2A
5. **Commissioning test** as per applicable standards as listed in Clause 10.00.00 of Section 2A

1.5 TECHNICAL QUALIFYING REQUIREMENT

The cable being offered are from manufacturer(s) who should have designed, manufactured, type tested and supplied single/multi core 33kV or higher grade XLPE insulated cable (of conductor size 185 Sqmm or above), of length at least the followings•

- (1.) 10 (ten) kilometer in a single contract, or
- (2.) 06 (six) kilometer each in two contracts

Which must be in satisfactory operation# for at least (two) years as on the originally scheduled date of techno-commercial bid opening.

satisfactory operation means certificate issued by the end customer certifying the operation without any adverse remark.

1.6 CALCULATION

Bidder to submit following calculations during detailed engineering stage

1. Short circuit calculation for metallic screen, Cu tape and armor
2. Armor coverage percentage
3. Calculation for SLV sizing / cross bonding arrangement

Any other calculations which may be required during detailed engineering stage shall also be submitted

1.7 EARTHING

1. Earthing of 33 kV cables system, including termination and joint along with required accessories shall be in supplier scope. Earth mat grid exists at both ends (33kV switchgear/Extension switchyard). Supply and installation of 40mm MS ROD, ROD electrode, 75X12 GI Flat & 50X6 GI Flat **is not in bidder's scope.**
2. Earthing of cable supports, cable tray **is not in bidder's scope.**

1.8 SPECIAL TECHNICAL REQUIREMENTS FOR CABLE TERMINATIONS & STRAIGHT THROUGH JOINTING KIT

Termination and jointing kits for 33 kV grade XLPE insulated cables shall be of proven design and make which have already been extensively used and type tested. Termination kits and jointing kits shall be pre-moulded type, taped type or heat shrinkable type. 33 kV grade joints and terminations shall be type tested as per IS: 13573. Critical components used in cable accessories shall be of tested and proven quality as per relevant product specification/ESI specification. Kit contents shall be supplied from the same source as were used for type testing. The kit shall be complete with the aluminum solder less crimping type cable lugs & ferrule as per DIN standard.

1.9 NOTES:

1. **Commissioning Test:** Provision of testing engineer & supply of all testing equipment to carry out commissioning test at site are in bidder's scope.
2. AC **supply** shall be arranged by BHEL/TANGEDCO from nearby grid.
3. Any other special tools, tackles, consumables and accessories required to complete the termination, jointing etc. shall be included in the offer.
4. Bidder to submit list of consumables with shelf life of less than two years. It shall be supplied before erection after clearance from BHEL.
5. **Lodging, Boarding, Accommodation and travel expenses for bidder's**

staff shall be in bidder's scope. Conveyance of supervisor at site shall arranged by BHEL.

1.10 QUALITY PLAN

Bidder to submit Quality Plan, the same shall be reviewed and approved during contract stage, it will be the bidder's responsibility to get its QP approved directly from the ultimate customer.

1.11 SCHEDULE:

1. Supplier will submit detailed bar chart indicating all the milestones from Engineering till manufacturing/ testing, dispatch to site and commissioning.

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SECTION-1 , BOQ
Project : 2 X 660MW TPS SEZ, ENNORE

Sl. no.	Description	Unit	Total Qty.	HSN No
1	19/33kV , 1C X 500 sq. mm Al Conductor XLPE insulated Armored cable	kM	42	85446090
2	33kV indoor heat shrinkable type cable termination kit complete in all respect suitable for 19/33kV, 1C X 500 sq. mm cable. (Creepage distance 31mm/kV) (1 set equals to termination for one end of single core cable)	Sets	18	85446090
3	33kV outdoor heat shrinkable type cable termination kit complete in all respect suitable for 19/33kV, 1C X 500 sq. mm cable. (Creepage distance 31mm/kV) (1 set equals to termination for one end of single core cable)	Sets	6	85446090
4	33kV heat shrinkable type straight through joint suitable for with or without cross bonding provision, complete in all respect for 19/33kV, 1C X 500 sq. mm cable. Outdoor type. (1 set equals to jointing between two single core cable)	Sets	66	85446090
5	Earthing link box with SVL (sheath voltage limiter) suitable for 19/33kV Cable cross bonded joint, including all cable/cable accessories/earthing material/mounting hardware e.t.c. required for completion of work. (1 set for 3x1-ph cable). Supply of 40mm MS Rod, 75X12mm GI Glat, 50X6mm GI flat are not in bidder scope.	Set	22	85446020
6	Earthing link box without SVL (sheath voltage limiter) suitable for 19/33kV Cable, including all cable/cable accessories/earthing material/mounting hardware of link box e.t.c. required for completion of work. (1 set for 3x1-ph cable). Supply of 40mm MS Rod, 75X12mm GI Glat, 50X6mm GI flat are not in bidder scope.	Set	4	85446020
7	The type test as per applicable standards as listed in Clause 9.03.00 of Section 2A (For samples required for complete scope of supply)	Lot	1	998346

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SECTION-1 , BOQ
Project : 2 X 660MW TPS SEZ, ENNORE

Sl. no.	Description	Unit	Total Qty.	HSN No
8	Supervision of 33kV cable laying on per day basis for one supervisor.	Man Day	10	998736
9	Supervision of Erection of 33kV indoor /outdoor heat shrinkable type cable termination kit, as per Sl. A.2 & A.3 above	Sets	24	998736
10	Supervision of Erection of 33kV heat shrinkable type straight through jointing kit, as per Sl. A.4 above	Sets	66	998736
11	Supervision of Erection of Earthing link box with/ withoutout SVL including all cable/cable accessories/earthing material e.t.c. required for completion of work. Complete as Sr No A.5 and A.6. Installation of 40mm MS Rod, 75X12mm GI Glat, 50X6mm GI flat are not in bidder scope .	Sets	26	998736
12	Site testing & commissioning for complete 33 kV cable System as per IS / IEC / IEE along with site testing equipment's on returnable basis.	Lot	1	998736

	Construction Details for 33kV Cable 2 x 660 MW ENNORE TPS	Doc. No. TB-378-510-034 (Part-2) Rev No. 2 Date 25.07.2017
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1.0 CONTENTS

1.1 This document is in continuation to Cable Sizing calculation - Document No: TB-378-510-034

2.0 SCOPE

2.1 The scope of this document covers the construction details for 33kV Power cable
2.2 Reference Documents

3.0 REFERENCE

3.0 a) Design calculations for MV Cable & Sizing Doc No: PE-DC-412-507-E001
3.0 a) Cable Sizing calculation - Document No: TB-378-510-034

S.NO.	ITEM	PARTICULARS
1	REFERENCE STANDARD	IS-7098 PART-II IN GENERAL
2	SYSTEM VOLTAGE	33 KV
3	VOLTAGE GRADE OF CABLES	19 / 33 KV (E)
4	CONDUCTOR	
a.	REFERENCE STANDARD	IS-8130
b.	MATERIAL	ALUMINIUM H2 GRADE CLASS 2
c.	SHAPE	MULTI-STRANDED COMPACTED CIRCULAR - THE ECCENTRICITY OF THE CORE SHALL NOT EXCEED 10% AND OVALITY NOT TO EXCEED 2%
d.	SIZES (NO. OF CORES -CROSS-SECTIONAL AREA)	500 Sqmm, Single Core
5	CONDUCTOR SCREENING	EXTRUDED SEMI-CONDUCTING COMPOUND MINIMUM THICKNESS: 0.8 MM
6	INSULATION	
a.	REFERENCE STANDARD	IS-7098 PART-II
b.	MATERIAL	EXTRUDED XLPE
7	INSULATION SCREENING	
a.	REFERENCE STANDARD	IS-7098 PART -II
b.	MATERIAL	
(i)	NON METALLIC	EXTRUDED SEMI-CONDUCTING COMPOUND MINIMUM THICKNESS: 0.8 MM
(ii)	METALLIC	THE METALLIC SCREEN OF EACH CORE SHALL CONSIST OF COPPER TAPE WITH MINIMUM OVERLAP OF 20%. NON-MAGNETIC METALLIC CU TAPE PER CORE SIZED FOR CARRYING EARTH FAULT CURRENT OF 300A FOR 1 SEC. MINIMUM THICKNESS: 0.1 MM

	Construction Details for 33kV Cable 2 x 660 MW ENNORE TPS	Doc. No. TB-378-510-034 (Part-2) Rev No. 2 Date 25.07.2017
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8	EXTRUSION (INSULATION AND SCREENS)	
a.	PROCESS	TRIPLE EXTRUSION. (EXTRUDED SEMI-CONDUCTING COMPOUND FOR CONDUCTOR SCREEN AND INSULATION SCREEN SHALL BE APPLIED ALONG WITH XLPE INSULATION IN A SINGLE OPERATION BY TRIPLE EXTRUSION DRY CURE PROCESS USING NITROGEN).
b.	METHOD OF CURING	DRY CURING USING NITROGEN
9	CORE IDENTIFICATION	NOT APPLICABLE
10	INNER SHEATH	
a.	REFERENCE STANDARD	IS-5831 & IS-7098 PART II
b.	MATERIAL	EXTRUDED HRPVC, FR-LSH CONFORMING TO TYPE ST2
b.1.	FILLERS (IF APPLICABLE)	ACCEPTABLE
b.2.	MATERIALS OF FILLERS	SAME AS INNER SHEATH
11	ARMOUR	
a.	REFERENCE STANDARD	IS- 3975, IS- 7098 PART II & IS 8130
b.	SINGLE CORE CABLES	
b.1.	MATERIAL	NON-MAGNETIC HARD DRAWN ALUMINIUM GRADE H4
b.2.	SHAPE	ROUND WIRE
12	SHORT CIRCUIT WITHSTAND CAPACITY	
a.	CONDUCTOR	25KA FOR 3 SEC
b.	COPPER TAPE SCREENING	300 A for 1 Sec
c.	ARMOUR	25KA FOR 1 SEC
13	OUTER SHEATH	
a.	REFERENCE STANDARD	IS-5831 & IS-7098 PART II
b.	MATERIAL	EXTRUDED HRPVC, FR-LSH CONFORMING TO TYPE ST2
14	CHARACTERISTICS OF HRPVC, FR-LSH SHEATH	
a.	OXYGEN INDEX	MIN. 29% (AS PER ASTM D 2863)
b.	TEMPERATURE INDEX	MIN. 250°C AT OXYGEN INDEX OF 21 (AS PER ASTM D 2863)
c.	ACID GAS GENERATION	MAX 20% (AS PER IEC 60754-1)
d.	SMOKE DENSITY RATING	MAX 60% (AS PER ASTM D 2843)

SECTION – 2A

EQUIPMENT SPECIFICATION

This section covers the general technical requirements of auxiliary power cables. In case of any discrepancies between the requirements mentioned in this section and those specified in other sections of this specification, this section shall prevail and shall be treated as binding. Requirements of Section-1 shall take precedence over all sections.

1.1 TECHNICAL REQUIREMENTS

GENERAL – Enclosed: Customer's Technical Specification.

VOL-IV: ELECTRICAL WORKS/HV CABLES/CHAPTER-15

Spec no: CE/C/P&E/EE/E/OT.NO 03/2013-14

CHAPTER – 15

HV CABLES

1.00.00 CODES & STANDARDS

1.01.00 All standards, specifications and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions as on date of opening of bid. In case of conflict between this specification and those (IS: codes, standards, etc.) referred to herein, the former shall prevail. All the cables shall conform to the requirements of the following standards and codes:

IS:7098 (Part -II)	Cross linked polyethylene insulated PVC sheathed cable for working voltage from 3.3 KV up to & including 33 KV.
IS : 3961	Recommended current ratings for cables
IS : 3975	Low Carbon Galvanized steel wires, formed wires and tapes for armouring of cables.
IS : 4905	Methods for random sampling.
IS : 5831	PVC insulation and sheath of electrical cables.
IS : 8130	Conductors for insulated electrical cables and flexible cords.
IS : 10418	Specification for drums for electric cables.
IS : 10810	Methods of tests for cables.
ASTM-D -2843	Standard test method for density of smoke from the burning or decomposition of plastics.
ASTM-D-2863	Standard method for measuring the minimum oxygen concentration to support candle like combustion of plastics.
IEC-754 (Part-I)	Test on gases evolved during combustion of electric cables.



IEEE-383	Standard for type test of Class IE Electric Cables.
IEC -332	Tests on Electric cables under fire conditions. Part-3 : Tests on bunched wires or cables (category -B)

2.00.00 GENERAL TECHNICAL REQUIREMENT

- 2.01.00 Power cable sizes shall be selected on the basis of current carrying capacity, short circuit rating, permissible voltage drop and standardization of cable sizes.
- 2.02.00 Power cables shall carry the full load current of the circuit continuously under site conditions considering the various derating factors like thermal resistivity of soil, ambient air/ground temperature, grouping, method of laying, etc. The design ambient air temperature and ground temperature shall be considered at 50 deg C and 30 deg C respectively.
- 2.03.00 The cables will be used for connection of power circuits of the system. All the power cabling shall be carried out by the contractor. Actual cable sizes will be selected by the Contractor. Number of different sizes selected will be kept to a minimum for optimization.
- 2.04.00 Cables shall be generally laid on ladder type cable trays or drawn, through rigid steel conduits. For inter plant connection cables shall be routed along overhead cable trestles/duct banks.
- 2.05.00 For continuous operation at specified rating, maximum conductor temperature shall be limited to the permissible value as per relevant standard and/or this specification.
- 2.06.00 The insulation and sheath materials shall be resistant to oil, acid and alkali and shall be tough enough to withstand mechanical stresses during handling.
- 2.07.00 Armouring shall be single round wire / strip of galvanized steel for multi core cables and aluminium for single core cable as per the relevant standards.
- 2.08.00 The inner and outer sheath shall have fire resistant low smoke (FRLS) characteristic and shall meet the requirements of additional tests specified for the purpose.



- 2.09.00 Core identification for multi core cable shall be provided by colour coding.
- 2.10.00 Cables shall be so designed and manufactured that no damage occurs during handling, transit, storage, installation under any operative conditions which they may be subjected to.
- 2.11.00 HV XLPE FRLS power cables shall be manufactured by triple extrusion dry cure (CCV) process using nitrogen.
- 2.12.00 Minimum value of volume resistivity for XLPE insulation shall be 1.0×10^{14} ohms-cm at 27 deg C and 1.0×10^{12} ohms-cm at 90 deg C.
- 2.13.00 Maximum continuous operating temperature shall be 90 deg C under normal operation and 250 deg C under short circuit condition.
- 2.14.00 Aluminium conductor used in power cables shall have tensile strength of more than 100 N/ sq.mm. Conductors shall be multi stranded.
- 2.15.00 The cable cores shall be laid up with fillers between the cores wherever necessary. It shall not stick to insulation and inner sheath.
- 2.16.00 The gap between armour wires / formed wire shall not exceed one armour wire / formed wire space and there shall be no cross over / over-riding of armour wire / formed wire. The minimum area of coverage of armouring shall be 90%. The breaking load of armour joint shall not be less than 95% of that of armour wire / formed wire. Zinc rich paint shall be applied on armour joint surface.
- 2.17.00 Cable Identification**
- 2.17.01 Cable identification shall be provided by embossing on every meter on the outer sheath the following:
- a) Owner's Name
 - b) Manufacturer's name or trademark
 - c) Voltage grade



- d) Year of manufacture
 - e) Type of insulation and sheath, e.g. XLPE / HRPVC FRLS as applicable.
 - f) No. of core and size of cables.
 - g) ISI Mark
 - h) Sequential length marking at an interval of 1m throughout the length of the cable.
- 2.17.02 Outer sheath shall be of PVC black in colour as per IS 5831. In addition to meeting all the requirements of Indian standards referred to, outer sheath of all the cables shall have the following FRLS properties:
- (a.) Oxygen index of min. 29 (to ASTM D 2863)
 - (b.) Acid gas emission of max. 20% (to IEC-60754-I).
 - (c.) Smoke density rating shall not be more than 60% during Smoke Density Test as per ASTM D-2843.
- 2.17.03 For reduced neutral conductors the core shall be black.
- 2.17.04 In addition to manufacturer's identification on cables as per IS, following marking shall also be provided over outer sheath:
- (a.) Cable size and voltage grade - To be embossed
 - (b.) Word 'FRLS' at every 5 metre - To be embossed
 - (c.) Sequential marking of length of the cable in metres at every one metre. To be embossed / printed
- The embossing / printing shall be progressive, automatic, in line and marking shall be legible and indelible.
- 2.18.00 All cables shall meet the fire resistance requirement as per IEEE - 383 with cable installations made in accordance with 'Flammability Test' and as per Category-B of IEC 60332 Part -3.



- 2.19.00 Allowable tolerances on the overall diameter of the cables shall be +/-2mm maximum over the declared value in the technical data sheets.
- 2.20.00 In plant, repairs to the cables shall not be accepted. Pimples, fish eye, blow holes etc. are not acceptable.
- 2.21.00 The cross-sectional area of the metallic screen strip/tape shall be considered in design calculations.

3.00.00 Cable selection & sizing

HV cables shall be sized based on the following considerations:

- Rated current of the equipment
- The voltage drop in the cable, during motor starting condition, shall be limited to 15% and during full load running condition, shall be limited to 5 % of the rated voltage.
- Short circuit withstand capability

The cables for circuit breaker controlled circuits shall withstand the maximum calculated fault currents for the following fault clearing times.

- | | |
|---|---------------|
| (a) Motor, service transformer (Protected by instantaneous over current protection) | -0.16 seconds |
| (b) Tie feeders (with no IDMT relays on Down-stream) | -0.5 seconds |
| (c) Others | -1 second |

In power cables maximum conductor size to be used will be 300 sq. mm & 630 sq.mm for multi core and single core cables. In case of multi core cables not more than 3 runs to be used or otherwise single core cable to be used.

4.00.00 Derating Factors

Derating factors for various conditions of installations including the following shall be considered while selecting the cable sizes:

- Variation in ambient temperature for cables laid in air
- Grouping of cables
- Variation in ground temperature and soil resistivity for buried cables.



4.01.00 Cable lengths shall be considered in such a way that straight through cable joints is avoided.

4.02.00 All cables shall be armoured type.

5.00.00 CONSTRUCTIONAL FEATURES

5.01.00 33kV/11kV /3.3 kV Grade Power Cables

Cables shall conform to IS: 7098 Part - II. These cables shall have multi- stranded, compacted circular shaped, aluminium conductors. The conductor screen and insulation screen shall both be of extruded semi conducting compound and shall be applied along with the XLPE insulation in a single operation of triple extrusion process so as to obtain continuously smooth interfaces. Thickness of these screens shall not be less than 0.8mm. The metallic screen of each core shall consist of copper tape with minimum overlap of 20%. The metallic screen shall be capable of carrying the system earth fault current for the specified duration. The eccentricity of the core shall not exceed 10% and ovality not to exceed 2%. Method of curing for cables shall be "dry curing / gas curing / steam curing".

6.00.00 SPECIFIC REQUIREMENTS / CONSTRUCTIONAL REQUIREMENTS

6.01.00 33kV/11KV/3.3 kV (UE), 90 Deg.C rating, heavy duty power cables with stranded aluminium conductor, extruded XLPE insulation, conductor and insulation screen, extruded HRPVC, FR-LSH inner sheath, aluminium round wire armour for single core cables and galvanised steel strip armour for three (3) core cables, and extruded HRPVC, FR-LSH overall sheath manufactured by triple extrusion dry cure (CCV) process using nitrogen.

6.02.00 Conductor

Stranded, compacted circular aluminium conductor of H2 grade, conforming to class-2 of IS: 8130 (1984).

6.03.00 Conductor Screening

Cross linked semi-conducting compound extruded in the same operation as the insulation.



6.04.00 Insulation

Cross linked polyethylene (XLPE) of natural colour, extruded over screened conductor. This shall be conforming to IS: 7098 Part-2 (1985).

6.05.00 Insulation Screening

All cables shall be provided with insulation screening. The insulation screening shall consist of extruded cross linked semi-conducting compound in combination with a layer of lapped copper tape of thickness not less than 0.1 mm.

6.06.00 Core Identification

a. Three (3) core cables, core identification shall not be done with different colouring of XLPE insulation, but with natural colour with coloured strips applied on the cores or by numerals printing on the cores.

b. Laying up of cores:

Cores shall be laid up together as per IS 7098 Part – 2 (1985).

c. Inner Sheath

Three (3) core cables, after laying up of cores, shall be provided with extruded HRPVC, FR-LSH inner sheath conforming to type ST2 of IS: 5831/1984. Such inner sheath shall be provided by pressure extrusion process without filler.

However, if in the process, the centre filler is required, the same shall be provided and material of centre filler shall be the same as inner sheath material.

Extruded FR-LSH inner sheath shall also be provided for single core cables.

6.07.00 Armour

For three (3) core cables: - Single galvanized steel strip armour conforming to IS: 3975 / 1988.



For Single Core Cables: - Armour shall be of Non magnetic material consisting of single hard drawn aluminium round wires conforming to H4 grade of IS: 8130 / 1984.

6.08.00 Overall Sheath

A tough overall sheath of extruded HRPVC, FR-LSH compound conforming to type ST2 of IS: 5831 / 1984 shall be provided over armour.

The colour of outer sheath shall be black.

6.09.00 Discharge free construction:

Inner conductor shielding/screening, XLPE insulation and outer core shielding /screening shall be extruded in one operation by special process (i.e. triple extrusion dry cure process) to ensure that the insulation is free from contamination and voids and perfect bonding of inner and outer shielding with insulation is achieved. The contractors are requested to elaborate the manufacturing technique adopted by their manufacturers to achieve this motive.

7.00.00 PACKING

7.01.00 Cables shall be supplied in non returnable wooden or steel drums of heavy construction. The surface of the drum and the outer most cable layer shall be covered with water proof cover. Both the ends of the cables shall be properly sealed with heat shrinkable PVC/ rubber caps secured by 'U' nails so as to eliminate ingress of water during transportation, storage and erection. Wood preservative anti-termite treatment shall be applied to the entire drum. Wooden drums shall comply with IS: 10418.

7.02.00 Each drum shall carry manufacturer's name, Owner's name, address and contract number, Type of cable & voltage grade, Year of manufacture, Type of insulation / sheath e.g. XLPE /HRPVC FRLS as applicable, No. of core and size of cables, Cable code, Length of cable on drum, ISI Mark, Approx. gross mass stenciled on both side of the drum. A tag containing same information shall be attached to the leading end of the cable. An arrow and suitable accompanying wording shall be marked on one end of the reel indicating the direction in which it should be rolled.



8.00.00 TESTS

8.01.00 Routine tests shall be carried out on 100% drums.

Type and acceptance tests shall be carried out on 1 drum selected on random basis, out of every 10 or less number of drums of each type and size of cable of each lot. Size shall mean area of cross section in sq.mm read in conjunction with the number of cores. Type shall mean type of insulation, sheath, volt grade FRLS/FS etc.

All acceptance and routine tests as per the specification and relevant standards shall be carried out. Charges for these shall be deemed to be included in the equipment price

All tests shall be witnessed by owner's representative.

In addition to standard Type, Routine & acceptance tests as per IS or other relevant standards as indicated elsewhere, to prove the fire resistant characteristics, each type of cable shall also be subject to the following additional type/ acceptance tests at works. The sample for these tests shall be selected based on criteria specified in IS 7098-II, Appendix A:

8.02.00 Oxygen index test as per ASTM D 2863. Minimum value of oxygen index shall be 29. The minimum value of temperature Index shall be 21 at 250 Deg.C.

8.03.00 Flammability tests on finished cable as per the requirements of IEEE-383, IEC-60332-1 and Swedish standard SS 4241475 clause F3.

8.04.00 Smoke generation by sheath under fire shall be as per ASTM D 2843. The cables shall meet the requirements of light transmission of minimum 40% after the test. The test shall be carried out by extrapolation method beyond temperature at which the material of sheath may start deformation as per BICC handbook chapter-6 on cable in fire.

8.05.00 Acid gas generation by sheaths under fire as per IEC-60754-1 and the minimum acid gas generation shall be less than 20% by weight.

8.06.00 Each type of cable shall also be subject to the following additional type test at works:-

Test for Rodent and termite repulsion properties



Test shall be conducted to note the presence of rodent and termite repelling chemical in PVC compound. Normal procedure is that a few chippings of PVC compound are slowly ignited in a porcelain dish in a muffle furnace at about 600 deg. C. The resulting ignited ash is boiled with a little ammonium acetate solution (10%). A drop of aqueous sodium sulphide solution is placed on a thick filter paper and it is allowed to soak. The spot is touched with a drop of above extract. A black spot indicates the presence of anti- termite & rodent compound.

9.00.00 TESTING PROCEDURE

9.01.00 Tests During Manufacture:-

During the manufacture of cables, manufacturer's standard tests shall be performed and record / test report shall be made available to purchaser's representative during inspection / testing.

9.02.00 Type Routine & Acceptance Tests:-

After completion of manufacture of cables, type, routine and acceptance tests shall be performed strictly as per relevant IS & other applicable standards amended up to date.

9.03.00 Type Tests:-

9.03.01 The type test as per applicable standards as given below shall be conducted on one drum selected on random basis out of every 10 drums or less of each type and size of cable (In presence of TANGEDCO representative). In case, facilities of any of the type tests are not available at the works of the supplier, then such type tests shall be carried out by the supplier at independent recognized Govt. approved laboratory at the cost of supplier.

1. Tensile test (for aluminium) as per IS:8130
2. Wrapping test (for aluminium) as per IS:8130



Note: - In the case of compacted circular & shaped conductors these tests shall be carried out before compacting/shaping for ensuring use of H2 grade aluminium.

3. Conductor Resistance test as per IS: 8130.
4. Test for armour wire/strip as per IS:3975
5. **Test for thickness of XLPE Insulation and HRPVC,FR-LSH sheath :-**

Requirements and methods of tests for the thickness of insulation, inner sheath and outer sheath shall be as per IS: 7098 (Part-2).

6. **Tensile strength and elongation test for insulation & sheath:-**

This test shall be carried out as per IS: 7098 Part-2 for XLPE cable.

7. **Ageing test for insulation and sheath:-**

The method of test shall be as per the relevant IS standard. The period of test shall be 168 hours (7 days). At the end of the ageing period, the tensile strength and elongation test shall be carried out as per Sr.No. (6) Above. The value obtained must not differ from the corresponding values obtained before ageing by more than + or - 25% in case of XLPE compound.

8. **Loss of mass test for HRPVC, FR-LSH sheath:-**

This test shall be carried out as per IS 583/1984 012 IEC 60540 & IEC 60502, on cables of all voltage grades. The maximum permissible loss of mass is 2 mg/sq.cm for PVC.

9. **Shrinkage test for XLPE insulation & HRPVC FR-LSH sheath:-**

This shall be carried out as per IS: 5831 – 1984 for sheathed and as per IS 7098 (Part 2) 1985 for XLPE insulation.

10. **Hot deformation test for HRPVC, FR-LSH sheath:-**



This shall be carried out as per IS: 5831 / 1984.

11. Cold Impact test for HRPVC, FR-LSH sheath:-

This shall be carried out as per IS: 5831.

12. Heat shock test for HRPVC, FR-LSH sheath:-

This test shall be carried out as per IS 5831 / 1984 and IEC 60540 and IEC 60502 & sheath shall pass the requirements of this test.

13. Thermal stability test for HRPVC, FR-LSH sheath:-

This test shall be carried out on cables as per IS 5831 / 1984 and IEC 60540 and cables shall pass the minimum requirements of 80 minutes for sheath.

14. Hot set test for XLPE Insulation:-

This test shall be carried out as per IS: 7098 Part-1 and Part-2 and cable shall pass the requirements given therein.

15. Test for bleeding and blooming of Pigments for HRPVC, FR-LSH Sheath

This shall be carried out as per IS: 5831 / 1984.

16. Fire Resistance Test:-

This test is compulsory and shall comply with the relevant clause of applicable IS.

17. Partial Discharge Test for XLPE Cables:-

The partial discharge test for XLPE insulation shall be carried out as per IS: 7098 (Part-II).

18. Bending Test for XLPE Cables:-

The test method and test requirement shall be as per IS: 7098 (Part-II). On completion of this test, the sample shall be subjected to partial discharge measurement and comply with the requirements given in above sub-clause 17.



19. Insulation Resistance / Volume resistivity -

As per IS 7098 Part-2 / 1985

20. Dielectric Power Factor Test

As per IS 7098 Part-2 / 1985.

21. Heating cycle test for XLPE Cables:-

This test shall be as per IS: 7098 (Part-II)

22. High Voltage Test:-

This test shall be performed as per the relevant Indian Standard 7098 Part 2 / 1985.

23. Test for Rodent & Termite Repulsion Property of Sheath:-

A few chipping of the PVC compound is slowly ignited on a porcelain dish or cubicle in a muffle furnace at about 60 degree C. The resulting ignited ash is boiled with a little ammonium acetate solution (10%). Place a drop of aqueous sodium sulphide solution on a thick filter paper and allow soaking. Touch the spot with a drop of above extract. A black spot indicates the presence of lead, the anti-termite and rodent compound.

24. Impulse Withstand Test

As per IS – 7098 (2) (amended upto date).

25. Water Absorption Test

As per IS 7098 Part-2 / 1985.

9.03.02 The normal sequence of the electrical tests shall be as per Clause 16.1.1 of IEC-60502/1978 and / or as per IS 7098 Part – 2 / 1985. All the tests listed herein shall be applied successively to the same sample.

9.03.03 The inner and outer sheath of the XLPE insulated cable shall be subjected to all the tests applicable for PVC sheath as per IS 5831 / 1984.



9.04.00 Special Tests On HRPVC 'FR-LSH' Material

All the sizes of 3.3 kV (UE)/11KV(E) XLPE power cables of the 'FRLS' HRPVC sheathed type shall pass following special test requirements. Inner sheath wherever applicable shall also be of the 'FR-LSH' type 'HRPVC' to meet these special tests.

- i) **Oxygen/Temperature Index test on sheath material:**-This test shall be carried out as per American National Std. ASTM-D-2863/77.

The minimum oxygen index shall be 29 at room temperature.

For determination of the temp.index, the oxygen index test shall be carried out at different temperature upto 250°C. However, the test shall be carried out by extra-polation method beyond temperature at which the material of sheath may start deformation. The minimum temperature index (i.e. the temperature at which the oxygen index is minimum 21) shall be 250°C generally as per BICC Hand Book Chapter-6.

- ii) **Acid gas emission test on sheath material:**-This test shall be carried out as per IEC 60754-1. The maximum acid gas emission shall be less than 20 by weight.

- iii) **Smoke density test on sheath material:**-This test shall be carried out as per American National Standard ASTM-D-2843/1977 and also as per UITP method (3M cube test on finished cable sample). **The ASTM test method is compulsory.** For passing this test, the requirement of light transmission shall be minimum 40% after the test.

- iv) **Flammability test on finished cable sample:** - This test shall be carried out as per the following method:

- **Swedish Std.SS:424-14-75 Class-F3.** This test known as Swedish Chimney test is compulsory.
- **IEEE 383-1974** – This test known as the vertical tray flame propagation test shall be conducted if insisted by purchaser.
- **IEC 60332-1.** – The cable should meet the requirement of all the above standards.



9.05.00**Routine Tests:**

The following tests shall be carried out as Routine tests on each and every drum length of cable, as per IS 7098 (Part 2) / 1985.

- a) High Voltage Test
- b) Conductor Resistance Test
- c) Partial discharge test (for screened cables) – on full drum length.

9.06.00**Acceptance Tests:**

The following test shall be carried out as Acceptance Test in the presence of TANGEDCO Inspecting Engineer on samples taken from the delivery lot. One drum out of every 10 number of drums or less shall be selected at random sampling basis in each lot for the Acceptance Tests which shall be carried out at manufacturers/supplier's cost.

- a) High Voltage Test
- b) Conductor Resistance Test
- c) Tensile / wrapping test.
- d) Partial discharge test (In screened cables).
- e) Insulation Resistance/Volume resistivity test
- f) Measurement of thickness of insulation and sheath and other dimensions
- g) Tensile strength & elongation at break for insulation & sheath.
- h) Hot set test on XLPE insulation
- i) Flammability test as per Swedish standard SS:424-15-75 Class-F-3 (Swedish Chimney test)
- j) Acid gas generation test as per IEC-60754-1.
- k) Smoke density test as per ASTM-D-2843/1977
- l) Oxygen index test as per ASTM-D 2863/1977
- m) Temp. index test as per ASTM-2863/77



10.00.00

COMMISSIONING

The contractor shall carry out the following commissioning tests and checks after installation at site. In addition the contractor shall carry out all other checks and tests as recommended by the manufacturers.

- a) Check for physical damage
- b) Check for insulation resistance before and after termination/jointing.
- c) HV cables shall be pressure tested (test voltage as per IS: 7098) before commissioning.
- d) Check of continuity of all cores of the cables.
- e) Check for correctness of all connections as per relevant wiring diagrams. Any minor modification to the panel wiring like removing/inserting, shorting, change in terminal connections, etc., shall be carried out by the Contractor.
- f) Check for correct polarity and phasing of cable connections.
- g) Check for proper earth connections for cable glands, cable boxes, cable armour, screens, etc.
- h) Check for provision of correct cable tags, core ferrules, and tightness of connections.



SECTION 2B

1.1 APPLICABLE STANDARDS OTHERS

The auxiliary power cables shall conform to following Indian and International standards.

IEC 502	Extruded solid dielectric insulated power cables for rated voltages from 1 kV upto 30 kV.
IS 1554 (Part I):1988	PVC insulated (heavy duty) electric cables - For working voltage up to and including 1100V
IS 5831:1984	PVC insulation and sheath of electric cables.
IS 8130:1984	Conductors for insulated electric cables and flexible cords.
IS 613:1984	Copper rods and bars for electrical purposes.
IS 3975:1988	Mild steel wires, formed and tapes for armouring of cable.
IS 10810:1984	Method of tests for cables.
IEEE-383:1974	Standard for type test of class IE electric cables, field splices, and connections for nuclear power generating stations.
ASTM-D2843,1993	Standard test method for density of smoke from burning or decomposition of plastics.
ASTM-D2863, 1991	Standard test method for measuring minimum oxygen concentration to support candle - like combustion of plastics (oxygen index).
NEMA-WC5,1992	Thermoplastic Insulated Wire and cable for the transmission and distribution of Electrical Energy.
IEC:754 (Part-1):1994	Test on gases evolved during combustion of electric cables - Determination of the amount of halogen acid gas evolved during combustion of polymeric materials taken from cables.
IEC:332 (Part I):1993	Test on electric cables under fire conditions Test on a single vertical insulated wire or cable.
IS 3961 (Part II):1967	Recommended current rating for cables - PVC insulated and PVC sheathed heavy duty cables.
IS 10418:1982	Drums for electric cables.

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TERMINATION KIT SPECIFICATION

2.1 GENERAL

This section covers the general technical requirements of Cable Termination Kits. In case of any discrepancies between the requirements mentioned in this section and those specified in the following sections of this specification, the specifications given herein shall prevail and shall be treated as binding requirements. Requirements of Section-1 shall take precedence over all sections.

2.2 APPLICABLE STANDARDS

All equipment and materials shall comply with the applicable provisions of the latest revisions of the Indian Standards and IEC 61442 1997 / IEC 60502-4 1998. Due attention shall be paid towards the provisions of following rules of the Indian Electricity Rules, 1956, as amended upto date:

- 42 Accidental charge
- 29 Construction, installation, protection, operation and maintenance of electric supply lines and apparatus

Standards other than following standards may be used with the prior written consent of purchaser, provided the specified design, constructional and performance requirements are satisfied. In such case, the bidder shall furnish two copies of the said applicable standard in English language along with the salient points of difference between the standard adopted and the specified standards shall be submitted for approval.

The applicable standards are listed below:

IS 13573:1992 & amendment 1996,1997	Joints and terminations of Polymeric cables for Voltages from 6.6 kV upto and including 33 kV - Performance
IS 7098 (Part - 2)	Requirements and Type tests. Specification for Cross-linked Polyethylene insulated PVC sheathed cables (from 3.3 kV upto 33 kV)
IEC 507	Specification for Salt fog test
VDE 0278	Accessories for cables rated upto 36 kV
IEEE 48:1975	Standard Test Procedures and Requirements for High Voltage Alternating Current Cable Accessories

2.2 SPECIFIC REQUIREMENTS AND DESIGN FEATURES

The cable termination kits shall be Class -1 as defined in IEEE 48 and shall be push-on type. The cable termination kits shall be suitable for termination of the cable on indoor switchgear or outdoor installation and shall be single phase types as specified in the Bill of Quantities.

The terminations shall be suitable for insulation voltage, conductor size and current rating of the cable.

The sealing ends shall withstand the power frequency & impulse voltage after installation as specified in Section-1.

The kits shall be suitable for the single core, XLPE-insulated, PVC-sheathed, Copper/Aluminium conductor cable of the size specified in Section 1.

Proper stress control, stress grading, non-tracking arrangement and seal from external environment in the termination shall be offered by means of proven methods, details of which shall be elaborated in the offer. Detailed sectional views of the assemblies shall be submitted alongwith the offer.

The impedance of the stress control cones shall not change for a temperature as low as (-)20°C. The impedance shall also remain constant inspite of the difference in stress which will exist within the cone due to heating effect within the conductor and the temperature of the surrounding environment.

The external leakage insulation between high voltage conductor and ground as specified in IEEE 48 shall be non-tracking, erosion-resistant and weather resistant flexible sleeve.

The offered kit shall provide for total environmental sealing of the cable crotch and at the lug end. The exact dimensions of cables shall be furnished at the time of order.

The kit shall be complete in all respects, complete with all accessories, jointing material, insulating stress control and sealing material as well as the instruction booklet explaining method of using the kit.

Material used for construction of a termination shall perfectly match with the dielectric, chemical and physical characteristics of the associated cable. The material and design concepts shall incorporate high degree of operating compatibility between the cable and the termination. Stress grading system involving taping is not acceptable.

The bidder shall indicate the required net dimensions of the indoor cable joints in the form of length, breadth and depth in millimeters.

The bidder shall specifically list the precautions to be observed while carrying out the termination to avoid any damage to the kit or cable or the personnel or installation. Detailed instructions with suitable illustrations shall be provided in an instruction booklet, which shall be furnished with each kit to enable proper execution of work.

2.4 TESTS

Bidder shall submit type test reports for cable termination kit conforming to IEC/IS requirements.

2.5 INFORMATION TO BE FURNISHED

All documents and drawings to be submitted for approval or the information of Purchaser shall be tailor-made for the equipment and the project for which it is being supplied.

The Contractor shall submit following drawings/ documents for approval of Purchaser:

- General arrangement and assembly drawings, giving details of sub assemblies, if any, to be reassembled at site.
- Detailed sectional views of the termination/ assembly, including environmental sealing of cable at both the lug and crutch ends.
- Detailed bill of material
- Quality plans along with reference values
- Type and routine test certificates.
- Instruction booklet
- Details of testing

2.6 TECHNICAL DOCUMENTS TO BE FURNISHED WITH THE OFFER

- Bidder shall furnish documentary evidence confirming requirements of volume resistivity and relative permittivity of the material of the stress control cones.
- Detailed sectional views of the termination/ assembly, including environmental sealing of cable at both the lug and crutch ends.
- Full details of the kit and its components.
- A copy of the booklet.
- Information required to be submitted with offer as per different clauses of the specification
- Type test certificates.
- Detailed bill of material

2.00.00 CODES AND STANDARDS

All standards, specifications and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions as on date of opening of bid. In case of conflict between this specification and those (IS codes, standards, etc.) referred to herein, the former shall prevail. All work shall be carried out as per the following standards/ codes as applicable.

IS:513	Cold rolled low carbon steel sheets and strips.
IS:1079	Hot Rolled carbon steel sheet & strips
IS:1239	Mild steel tubes, tubular and other wrought steel fittings
IS:1255	Code of practice for installation and maintenance of power cables upto and including 33 KV rating
IS:1367 Part-13	Technical supply conditions for threaded Steel fasteners. (Hot dip galvanized coatings on threaded fasteners).
IS:2147	Degree of protection provided by enclosures for low voltage switchgear and control gear
IS:9537	Conduits for electrical installation.
IS:9595	Metal – arc welding of carbon and carbon manganese steels - recommendations.
IS:13573	Joints and terminations for polymeric cables for working voltages from 3.3kv up to and including 33kv performance requirements and type tests.
BS:476	Fire tests on building materials and structures
DIN 46267 (Part-II)	Non tension proof compression joints for Aluminium conductors.
DIN 46329	Cable lugs for compression connections, ring type ,for Aluminium conductors
VDE 0278	Tests on cable terminations and straight through joints
BS:6121	Specification for mechanical Cable glands for elastomers and plastic insulated cables.
	Indian Electricity Act.
	Indian Electricity Rules.



2x660 MW Ennore SEZ Supercritical Thermal Power
Project at Ash Dyke of NCTPS
Spec. No. CE/C/P&E/EE/E/OT. No. 03/2013-14
Vol. IV: Electrical Works:426



SECTION – 3

PROJECT INFORMATION AND GENERAL TECHNICAL REQUIREMENTS

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CHAPTER 1

PROJECT SYNOPSIS

1.0 GENERAL BACKGROUND AND SALIENT FEATURES

1.1 Introduction

Tamilnadu Generation and Distribution Corporation owns the proposed green-field 1320 MW (2 units of 660 MW each) Coal Based Thermal Power Station at Katupalli. This is an expansion of North Chennai Thermal Power Station (NCTPS) and located on some portion of the ashdyke of NCTPS.

1.2 Location

The proposed site for main power plant is located near Ennore port (approx 5 kms).

The nearest Railway station is at Athipattu Pudunagar (approx 5 kms)

All weather road from Pattamandri on the Thiruvottiur-Ponneri district highway is the nearest road access.

The nearest airport is at Chennai at a distance of 60 km.

1.3 NA

1.4 PROJECT INFORMATION

Project Title : **2 x 660 MW Ennore SEZ Coal Based Supercritical Thermal Power Project at Ash Dyke of NCTPS**

Owner : **TAMIL NADU GENERATION AND DISTRIBUTION CORPORATION (TANGEDCO)**

LOCATION

The site is located near Vayalur Village, Ennore

Latitude : 13°17' N to 13°18' N

Longitude : 80°18' E to 80°19' E

Distance from Chennai City : 35 km

Nearest Airport is at Chennai at a

Distance of : 60 km

Nearest Seaport is : Ennore

Nearest Railway Station is : Athipattu Pudunagar (approx 5 kms)

Meteorological Condition

Climate : Tropical ,very dry and hot summer, dry and cold winter and good rain-fall in monsoon accompanied with strong wind.

Climatological data	:		
Ambient temp. (°C)	:	Annual Maximum Mean Temp	41.5(°C)
	:	Annual Minimum Mean Temp	24(°C)
	:	Design Ambient temperature	50(°C)
Relative Humidity	:	Maximum 100% Minimum 36% Design 75%	
Annual Rainfall	:	Maximum 2540 mm Average 1600 mm Minimum 1175 mm	
Prevailing Wind Direction	:	Nov to Jan – From NW & NE Feb to Mar – From East & SE Apr to May – From South & SE June – From SW July to Aug – From NW Sept to Oct – From SE & SW Wind Speed 11.8 kmph (avg) 50 kmph (max)	

Seismic Zone	:	Seismic Zone III as per IS:1893-2002 minimum 0.16 g horizontal	
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1.5

1.7

Access to Site

Site is well connected to all weather road from Pattamandri on the Thiruvottiyur – Ponneri district highway. Site is located adjacent to the Chennai – Howrah broad gauge line and thus well connected by rail also.

CHAPTER – 2

GENERAL TECHNICAL REQUIREMENTS

1.00.00 ELECTRICAL SYSTEM PARTICULARS

1) Standard voltage levels

The standardized voltage levels as shall be adopted as specified elsewhere in this specification.

2) Permissible variations:

The system unit/plant equipment shall be designed suitable for continuous operation with variation in voltage and frequency as indicated below:

3) Variation in voltage and frequency

	Voltage	Frequency
Permissible variation for power supply with rated Performance /rated current and control effectiveness maintained	+/- 10%	-5% to +3%
Permissible variation for control and regulation equipment with rated Performance and control quality maintained		

4) Basic insulation levels

Equipment shall be designed suitable for basic insulation levels as given below:

Nominal Voltage (kV)	BIL kV (peak)
400 kV	1425
33 kV	170
11 kV	75
3.3 kV	40

5) Symmetrical short circuit ratings

The three phase symmetrical short circuit ratings of the switchgear at different voltage levels shall be as indicated in the Table below:

S. No.	Voltage level	Symmetrical Breaking Capacity	Making Capacity
1.	400 kV	63 kA for 1 sec	163 kA
2.	33 kV	25 kA for 3 sec	62.5 kA
3.	11 kV	50 kA for 3 sec	125 kA
4.	3.3 kV	40 kA for 3 sec	100 kA
5.	415 V	50 kA for 1 sec	125 kA
6.	220 V DC	25 kA for 1 sec	-
7.	48 V DC	10 kA for 1 sec	

6) Criteria for selection of voltage levels for motors

Sr. No	Rating	Voltage Level
1	LV Motors- Up to 160 kW	415 V, 3 phase, 50 Hz
2	MV Motors- More than 160 kW and up to 1500 kW	3.3 kV, 3 phase, 50 Hz
3	HV Motors- Above 1500 kW	11 kV, 3 phase, 50 Hz

7) System Earthing

- i. 33kV/11 kV and 3.3 kV : Resistance grounded.
- ii. 415 V : Solidly grounded.

8) Degree of Protection:

Degree of protection for various electrical equipment shall be as follows:

S.No.	Equipment	Degree of Protection
1.	Marshalling Boxes, Panels, Motors located outdoor	IP55
2.	Electrical Equipment of CH System	IP55 with dust proof enclosure
3.	HV Switchgear	IP-4X for bus bar chamber, IP-6X for other compartments
4.	LV Switchgear	IP52 up to 1600 A and IP42 above 1600 A

2.00.00 GENERAL TECHNICAL PARTICULARS FOR EHV SYSTEM

(a)	Rated voltage	400 kV
(b)	Rated frequency	50 Hz
(c)	Rated short time current withstand capacity	63 kA rms for one (1) second
(d)	Rated one minute power frequency withstand voltage	650 kV rms between live terminals and earth b) 815 kV rms across isolating distance
(e)	Rated lightning impulse withstand voltage	a) 1425 kVp between live terminals b) 1425 (+240) kVp across isolating distance & earth.
(f)	Rated Switching Impulse withstand voltage	a) 1575 kVp (between phases) b) 900 (+345) (across isolating distance)
(g)	Phase to phase spacing	4000 mm
(h)	Rated terminal load	Adequate to withstand 100 kg static load as well as wind, seismic and short circuit forces without impairing reliability or current carrying capacity.
(i)	System neutral earthing	Effectively earthed
(j)	Support structure height	Adequate so that lowest part of support insulator of equipment is 2550 mm (minimum) from ground and/or plinth level.
(k)	Creepage distance	Minimum 31 mm / kV
(l)	Electrical Clearances	

Clearances shall be as given below and as per relevant statutory rules/codes.		
1.	Phase to earth	3500 mm
2.	Phase to phase	4000 mm
3.	Sectional clearance	6500 mm
4.	Ground clearance	8000 mm

3.00.00 NA

4.00.00 COMPLETENESS

4.01.00 Bidders may note that this is a contract inclusive of the scope as indicated elsewhere in the specification. Each of the plant shall be engineered and designed in accordance with the specification requirement. All engineering and associated services are required to ensure that a completely engineered plant is provided.

4.02.00 All equipment furnished by the Bidder shall be complete in every respect, with all mountings, fittings, fixtures and standard accessories normally provided with such equipment and/or those needed for erection, completion and safe operation & maintenance of the equipment and for the safety of the operating personnel, as required by applicable codes, though they may not have been specifically detailed in the respective specifications, unless included in the list of exclusions.

All similar standard components/ parts of similar standard equipment provided, shall be interchangeable with one another.

5.00.00 CODES & STANDARDS

5.01.00 In addition to the codes and standards specifically mentioned in the relevant technical specifications for the equipment / plant / system, all equipment parts, systems and works covered under this specification shall comply with all currently applicable statutory regulations and safety codes of the Republic of India as well as of the locality where they will be installed, including the following:

- (a.) Bureau of Indian Standards (BIS)
- (b.) Indian electricity act
- (c.) Indian electricity rules
- (d.) Indian Explosives Act

- (e.) Indian Factories Act and State Factories Act
- (f.) Indian Boiler Regulations (IBR)
- (g.) Regulations of the Central Pollution Control Board, India
- (h.) Regulations of the Ministry of Environment & Forest (MoEF), Government of India
- (i.) Pollution Control Regulations of Department of Environment, Government of India
- (j.) State Pollution Control Board.
- (k.) Rules for Electrical installation by Tariff Advisory Committee (TAC).
- (l.) Any other statutory codes / standards / regulations, as may be applicable.

5.02.00 Unless covered otherwise by Indian codes & standards and in case nothing to the contrary is specifically mentioned elsewhere in the specifications, the latest editions (as applicable as on date of bid opening), of the codes and standards given below shall also apply:

- (a.) Japanese Industrial Standards (JIS)
- (b.) American National Standards Institute (ANSI)
- (c.) American Society of Testing and Materials (ASTM)
- (d.) American Society of Mechanical Engineers (ASME)
- (e.) American Petroleum Institute (API)
- (f.) Standards of the Hydraulic Institute, U.S.A.
- (g.) International Organisation for Standardization (ISO)
- (h.) Tubular Exchanger Manufacturer's Association (TEMA)
- (i.) American Welding Society (AWS)
- (j.) National Electrical Manufacturers Association (NEMA)
- (k.) National Fire Protection Association (NFPA)
- (l.) International Electro-Technical Commission (IEC)
- (m.) Expansion Joint Manufacturers Association (EJMA)
- (n.) Heat Exchange Institute (HEI)

5.03.00 Other International/ National standards such as DIN, VDI, BS, etc. shall also be accepted for only material codes and manufacturing standards, subject to the Owner's approval, for which the Bidder shall furnish, alongwith the offer, adequate information to justify that these standards are equivalent or superior to the standards mentioned above. In all such cases the Bidder shall furnish specifically the variations and deviations from the standards mentioned else

where in the specification together with the complete word to word translation of the standard that is normally not published in English.

5.04.00 — NA

5.05.00 NA

5.06.00 NA

5.07.00 In case of any change in codes, standards & regulations between the date of bid opening and the date when vendors proceed with fabrication, the Owner shall have the option to incorporate the changed requirements or to retain the original standard. It shall be the responsibility of the Bidder to bring to the notice of the Owner such changes and advise Owner of the resulting effect.

6.00.00 EQUIPMENT FUNCTIONAL GUARANTEE

6.01.00 The Equipment and Auxiliaries shall be capable of continuous operation in frequency range of 47.5 to 51.5 Hz.

7.00.00 DESIGN OF FACILITIES/ MAINTENANCE & AVAILABILITY CONSIDERATIONS

7.01.00 Design of Facilities

All the design procedures, systems and components proposed shall have already been adequately developed and shall have demonstrated good reliability under similar conditions elsewhere.

The Bidder shall be responsible for the selection and design of appropriate equipment to provide the best co-ordinate performance of the entire system. The basic requirements are detailed out in various clauses of the Technical Specifications. The design of various components, assemblies and subassemblies shall be done so that it facilitates easy field assembly and dismantling.

7.02.00 Maintenance and Availability Considerations

Equipment offered shall be designed for high availability, low maintenance and ease of maintenance. The Bidder shall specifically state the design features incorporated to achieve high degree of reliability/ availability and ease of maintenance. The Bidder shall also furnish details of availability records in the reference plants stated in his experience list.

Bidder shall state in his offer the various maintenance intervals, spare parts and man-hour requirement during such operation. The intervals for each type of maintenance namely the minor and major overhauls shall be specified in maintenance manuals, clearly defining the spare parts and man-hour requirement for each stage.

8.00.00 DOCUMENTS, DATA AND DRAWINGS TO BE FURNISHED BY BIDDER

8.01.00 Each of the equipment shall be fully integrated, engineered and designed to perform in accordance with the technical specification. All engineering and technical services required ensuring a completely engineered plant shall be provided as per the scope.

The Bidder shall furnish engineering data/drgs. in accordance with the schedule of information as specified in Technical Specification and data sheets.

- 8.02.00 The number of copies/prints/CD-ROMs/manuals to be furnished for various types of documents is given in Chapter 4.
- 8.03.00 The documentation that shall be provided by the Bidder is indicated in various sections of specification. The documentation shall include but not be limited to the following:

Basic Engineering Documentation

Prior to commencement of the detailed engineering work, the Bidder shall furnish a Equipment Definition Manual within 4-6 weeks from the date of the Purchase Order. This manual shall contain the following as a minimum:

- i. System description of all the mechanical, electrical, control & civil systems.
- ii. Technology scan for each system / sub-system & equipment.
- iii. Selection of appropriate technology / schemes for various systems/ subsystems including techno-economic studies between various options.
- iv. NA.
- v. Sizing criteria of all the systems, sub-systems including various equipment/ structures/ equipment foundations along with all calculations justifying and identifying the sizing and the design margins.
- vi. Schemes and Process & Instrumentation diagrams for the various systems/ sub-system with functional write-ups.
- vii. Operation Philosophy and the control philosophy.
- viii. General Layout plan.
- ix. NA
- x. Documentation in respect of Quality Assurance System as listed out elsewhere in this specification.
- xi. NA
- xii. NA
- i. Layouts, general arrangements, elevations and cross-sections drawings for all the equipment and facilities of the plant.
- ii. NA

- iii. NA
- iv. NA
- v. NA
- vi. Technical data sheets for all bought out and manufactured items. Bidder shall use the specifications as a base for placement of orders on their sub-vendors.
- vii. Detailed design calculations for components, system/sub-system, etc., wherever applicable including sizing calculations as per criteria specified elsewhere in specification.
- viii. NA
- ix. NA
- x. NA
- xi. NA
- xii. NA
- xiii. Power supply single line diagram, block logics, control schematics, electrical schematics, etc.
- xiv. NA
- xv. Interconnection diagrams.
- xvi. Cable routing plan.
- xvii. Instrument schedule, measuring point list, I/O list, Interconnection & wiring diagram, functional write-ups, installation drawings for field mounted instruments, logic diagrams, control schematics, wiring diagrams of panels and enclosures etc.
- xviii. Alarm and annunciation list and alarms & trip set points.
- xix. Sequence and protection interlock schemes.
- xx. Type test reports
- xxi. Control system configuration diagrams and card circuit diagrams and maintenance details.
- xxii. Detailed software manuals & source software listing.
- xxiii. Detailed flow chart for digital control system.
- xxiv. Mimic diagram layout.
- xxv. Civil Task drawings(for the Engineering by BHEL),Design and Drawings.
- xxvi. Model study reports wherever applicable.
- xxvii. NA
- xxviii. Documentation in respect of Quality Assurance System as listed out elsewhere in this specification.
- xxix. Documentation in respect of commissioning as listed out elsewhere in this specification.

8.03.01 Instruction Manuals

The Bidder shall submit, draft Instruction Manuals for all the equipment covered under the Contract by the end of one year from the date of his acceptance of the Letter of Award. The Instruction manuals shall contain full details required for erection, commissioning, operation and maintenance of each equipment. The manual shall be specifically compiled for this project. After finalization and approval of the BHEL / OWNER the Instruction Manuals shall be submitted as indicated in Chapter-4. **The Contract shall not be considered to be completed for purposes of taking over until the final Instructions manuals with As Built drawings have been supplied.** The Instruction Manuals shall comprise of the following.

Erection Manuals

The erection manuals shall be submitted atleast three (3) months prior to the commencement of erection activities of particular equipment/system. The erection manual should contain the following as a minimum.

- a) Erection strategy.
- b) Sequence of erection.
- c) Erection instructions.
- d) Critical checks and permissible deviation/tolerances.
- e) List of tool, tackles, heavy equipment like cranes, dozers, etc.
- f) Bill of Materials
- g) Procedure for erection.
- h) General safety procedures to followed during erection/installation.
- i) Procedure for initial checking after erection.
- j) Procedure for testing and acceptance norms.
- k) Procedure / Check list for pre-commissioning activities.
- l) Procedure / Check list for commissioning of the system.
- m) Safety precautions to be followed in electrical supply distribution during erection

Operation & Maintenance Manuals

- i. The operating and maintenance instructions together with drawings (other than shop drawings) of the equipment, as completed, shall be in sufficient detail to enable the BHEL / OWNER to operate, maintain, dismantle, reassemble and adjust all parts of the equipment. They shall give a step by step procedure for all operations likely to be carried out during the life of the plant / equipment including, operation, maintenance, dismantling and repair including periodical activities such as chemical cleaning of the generator. Each manual shall also include a complete set of drawings together with performance/rating curves of the equipment and test certificates wherever applicable. The contract shall not be considered to be completed for purposes for taking over until these manuals have been supplied.
- ii. If after the commissioning and initial operation of the plant, the manuals require any modification / additions / changes, the same shall be incorporated and the updated final instruction manuals shall be submitted to the BHEL / OWNER for records.
- iii. A separate section of the manual shall be for each size/ type of equipment and shall contain a detailed description of construction and operation, together with all relevant pamphlets and drawings.

- iv. The manuals shall include the following :
 - a) List of spare parts along with their drawing and catalogues and procedure for ordering spares.
 - b) Lubrication Schedule including charts showing lubrication checking, testing and replacement procedure to be carried daily, weekly, monthly & at longer intervals to ensure trouble free operation.
 - c) Where applicable, fault location charts shall be included to facilitate finding the cause of maloperation or break down.
- v. Detailed specifications for all the consumables including lubricant oils, greases, chemicals etc. system/equipment/assembly/sub-assembly - wise required for the complete plant.
- vi. On completion of erection, a complete list of bearings / equipment giving their location, and identification marks etc. shall also be furnished to the BHEL / OWNER indicating lubrication method for each type/category of bearing.

8.03.02

Plant Handbook

The Bidder shall submit to the BHEL / OWNER a preliminary plant hand book preferably in A-4 size sheets which shall contain the design and performance data of various equipment and systems covering the complete project including	
1.	Design and performance data.
2.	Process & Instrumentation diagrams.
3.	Single line diagrams.
4.	Sequence & Protection Interlock Schemes.
5.	Alarm and trip values.
6.	General layout plan
7.	Important Do's & Don't's
8.	The plant handbook shall be submitted within twelve (12) months from the date of award of contract. After the incorporation of BHEL / OWNER's comments, the final plant handbook complete in all respects shall be submitted three (3) months before start-up and commissioning activities.

8.03.03

Project Completion Report

The Bidder shall submit a Project Completion Report at the time of handing over the plant.

8.03.04

Drawings

- (a.) All documents submitted by the Bidder for BHEL / OWNER's review shall be in electronic form (soft copies) **along with the desired**

number of hard copies as per Chapter-4. The soft copies to be supplied shall be either in CDs, or through direct transfer via E-mail, etc. depending upon the nature/volume/size of the document. The drawings submitted for approval could be in the Image form.

- (b.) Final copies of the approved drawings shall be submitted on CD-ROM along with the requisite number of hard copies as per Chapter-4.
- (c.) The completed plant documentation with equipment drawings, data sheets, P&ID, BOQ, schematics, logic diagrams, test reports and quality plan, etc. shall be furnished to BHEL / OWNER.
- (d.) All documents/text information shall be in latest version of MS Office.
- (e.) All drawings submitted by the Bidder including those submitted at the time of bid shall be in sufficient detail indicating the type, size, arrangement, weight of each component for packing and shipment, the external connection, fixing arrangement required, the dimensions required for installation and interconnections with other equipment and materials, clearance and spaces required between various portions of equipment and any other information specifically requested in the drawing schedules.
- (f.) Each drawing submitted by the Bidder (including those of sub-vendors) shall bear a title block at the right hand bottom corner with clear mention of the name of the BHEL / OWNER, Consultant, name of the Project, system designation, the specifications title, the specification number, drawing/document number and revisions. If standard catalogue pages are submitted the applicable items shall be indicated therein. All titles, notings, markings and writings on the drawing shall be in English. All the dimensions should be in metric units.
- (g.) The Bidder shall also furnish a "Master Drawing List" which shall be a comprehensive list of all drawings/ documents/ calculations envisaged to be furnished by him during the detailed engineering to the BHEL / OWNER. Such list should clearly indicate the purpose of submission of these drawings i.e. "FOR APPROVAL" or "FOR INFORMATION ONLY".
- (h.) Similarly, all the drawings/ documents submitted by the Bidder during detailed engineering stage shall be stamped "FOR APPROVAL" or "FOR INFORMATION" prior to submission.
- (i.) The furnishing of detailed engineering data and drawings by the Bidder shall be in accordance with the time schedule for the project. The review of these documents/ data/ drawings by the Owner will cover only general conformance of the data/ drawings/ documents to the specifications and contract, interfaces with the equipment provided by others and external connections & dimensions which might affect plant layout. The review by the Owner should not be construed to be a thorough review of all dimensions, quantities and details of the equipment, materials, any devices or items indicated or the accuracy

of the information submitted. The review and/ or approval by the BHEL / OWNER / Project Manager shall not relieve the Bidder of any of his responsibilities and liabilities under this contract.

- (j.) After the approval of the drawings, further work by the Bidder shall be in strict accordance with these approved drawings and no deviation shall be permitted without the written approval of the BHEL / OWNER.
- (k.) All manufacturing, fabrication and execution of work in connection with the equipment / system, prior to the approval of the drawings, shall be at the Bidder's risk. The Bidder is expected not to make any changes in the design of the equipment /system, once they are approved by the BHEL / OWNER. However, if some changes are necessitated in the design of the equipment/system at a later date, the Bidder may do so, but such changes shall promptly be brought to the notice of the BHEL / OWNER indicating the reasons for the change and get the revised drawing approved again in strict conformance to the provisions of the Technical Specification.
- (l.) Drawings shall include all installations and detailed piping layout drawings. Layout drawings for all piping of 65 mm and larger diameter shall be submitted for review/ approval of BHEL / OWNER prior to erection. Small diameter pipes shall however be routed as per site conditions in consultation with site authority/representative of BHEL / OWNER based on requirements of such piping indicated in approved / finalized Flow Scheme / Process & Instrumentation Diagrams and/or the requirements cropping up for draining & venting of larger diameter piping or otherwise after their erection as per actual physical condition for the entire scope of work of this package.
- (m.) Assessing & anticipating the requirement and supply of all piping and equipment shall be done by the Bidder well in advance so as not to hinder the progress of piping & equipment erection, subsequent system charging and its effective draining & venting arrangement as per site suitability.
- (n.) As Built Drawings

After final acceptance of individual equipment/system by the BHEL / OWNER, the Bidder will update all original drawings and documents for the equipment/ system to "as built" conditions.

- (o.) Drawings must be checked by the Bidder in terms of its completeness, data adequacy and relevance with respect to Engineering schedule prior to submission to the BHEL / OWNER. In case drawings are found to be submitted without proper endorsement for checking by the Bidder, the same shall not be reviewed and returned to the Bidder for re-submission. The Bidder shall make a visit to site to see the existing facilities and understand the layout completely and collect all necessary data/drawings at site which are needed as an input to the engineering. The Bidder shall do the complete engineering including interfacing and integration of all his equipment, systems & facilities within his scope of work as well as interface engineering & integration

of systems, facilities, equipment & works under BHEL/OWNER's scope and submit all necessary drawings/ documents for the same.

- (p.) The Bidder shall submit adequate prints of drawing/data/document for Owner's review and approval. The BHEL/OWNER shall review the drawings and return one (1) copy to the Bidder authorizing either to proceed with manufacture or fabrication, or marked to show changes desired. When changes are required, drawings shall be re-submitted promptly, with revisions clearly marked, for final review. Any delays arising out of the failure of the Bidder to submit/rectify and resubmit in time shall not be accepted as a reason for delay in the contract schedule.
- (q.) All engineering data submitted by the Bidder after final process including review and approval by the BHEL/OWNER shall form part of the contract documents and the entire works covered under these specification shall be performed in strict conformity with technical specifications unless otherwise expressly requested by the BHEL/OWNER in writing.

8.04.00 **Engineering Information Submission Schedule**

Prior to the award of Contract, a Detailed Engineering Information Submission Schedule shall be tied up with the BHEL/OWNER. For this, the bidder shall furnish a detailed list of engineering information alongwith the proposed submission schedule. This list would be a comprehensive one including all engineering data / drawings / information for all bought out items and manufactured items. The information shall be categorised into the following parts.

- (a.) Information that shall be submitted for the approval of the BHEL/OWNER before proceeding further, and
- (b.) Information that would be submitted for BHEL/OWNER's information only.

The Engineering Information Schedule shall be updated monthwise.

The schedule should allow adequate time for proper review and incorporation of changes/modifications, if any, to meet the contract without affecting the equipment delivery schedule and overall project schedule. The early submission of drawings and data is as important as the manufacture and delivery of equipment and hardware and this shall be duly considered while determining the overall performance and progress.

8.05.00 **Engineering Progress and Exception Report**

8.05.01 Report giving the status of each engineering information including

- (a.) A list of drawings/engineering information which remains unapproved for more than four (4) weeks after the date of first submission
- (b.) Drawings which were not submitted as per agreed schedule.

8.05.02 The draft format for this report shall be furnished to the BHEL/OWNER within four (4) weeks of the award of the contract, which shall then be discussed and finalized with the BHEL/OWNER.

8.06.00 **Co-Ordination Meetings**

8.06.01 The Bidder shall be called upon to attend monthly Design/ Co-ordination Meetings (if required) with the BHEL/OWNER/Owner's representatives, Project Consultant during the period of contract. The Bidder shall attend such meetings at his own cost at mutually agreed venue as and when required and fully co-operate with such persons and agencies involved during the discussions.

8.06.02 The Bidder should note that Time is the essence of the contract. In order to expedite the early completion of engineering activities, the Bidder shall submit all drawings as per the agreed Engineering Information Submission Schedule. The drawings submitted by the Bidder will be reviewed by the BHEL/OWNER as far as practicable within three (3) weeks from the date of receipt of the drawing. The comments of the BHEL/OWNER shall then be discussed across the table during the above co-ordination Meetings wherein best efforts shall be made by both sides to ensure the approval of the drawing.

8.06.03 The Bidder shall ensure availability of the concerned experts / consultants/ personnel who are empowered to take necessary decisions during these meetings. The Bidder shall be equipped with necessary tools and facilities so that the drawings/documents can be resubmitted after incorporating necessary changes and approved during the meeting itself.

8.06.04 Should any drawing remain unapproved for more than six (6) weeks after it's first submission, this shall be brought out in the monthly Engineering Progress and Exception Report with reasons thereof.

8.06.05 Any delays arising out of failure by the Bidder to incorporate Owner's comments and resubmit the same during the TCM shall be considered as a default and in no case shall entitle the Bidder to alter the Contract completion date.

8.07.00 **Design Improvements**

The BHEL/OWNER or the Bidder may propose changes in the specification of the equipment or quality thereof and if the parties agree upon any such changes the specification shall be modified accordingly.

If any such agreed upon change is such that it affects the price and schedule of completion, the parties shall agree in writing as to the extent of any changing the price and/or schedule of completion before the Bidder proceeds with the change. Following such agreement, the provision thereof, shall be deemed to have been amended accordingly.

8.08.00 **NA**

8.09.00 **NA**

8.10.00 **Lubricants, Servo Fluids and Chemicals**

8.10.01 The Bidder's scope includes all the first fill and one year's topping, requirements of consumables such as oils, lubricants including grease, fluids, gases and essential chemicals etc. Consumption of all these consumables during the initial operation and final filling after the initial operation shall also be included in the scope of the Bidder. Bidder shall also supply a quantity not less than 10% of the full charge of each variety of lubricants, servo fluids, gases, chemicals etc. used which is expected to be utilised during the first year of operation. This additional quantity shall be supplied in separate Containers.

8.11.00

NA

8.12.00

Material of Construction

8.12.01 All materials used for the construction of the equipment shall be new and shall be in accordance with the requirements of this specification. Materials utilized for various components shall be those which have established themselves for use in such applications.

8.13.00

Rating Plates, Name Plates & Labels

8.13.01 Each main and auxiliary item of plant including instruments shall have permanently attached to it in a conspicuous position, a rating plate of non-corrosive material upon which shall be engraved manufacturer's name, equipment, type or serial number together with details of the ratings, service conditions under which the item of plant in question has been designed to operate, and such diagram plates as may be required by the BHEL/OWNER.

8.13.02 Each item of plant shall be provided with nameplate or label designating the service of the particular equipment. The inscriptions shall be approved by the BHEL/OWNER or as detailed in appropriate section of the technical specifications.

8.13.03 Such nameplates or labels shall be of white non-hygroscopic material with engraved black lettering or alternately, in the case of indoor circuit breakers, starters, etc. of transparent plastic material with suitably coloured lettering engraved on the back. The name plates shall be suitably fixed on both front and rear sides.

8.13.04 Items of plant such as valves, which are subject to handling, shall be provided with an engraved chromium plated nameplate or label with engraving filled with epoxy. The name plates for valves shall be marked in accordance with MSS standard SP-25 and ANSI B 16.34 as a minimum.

8.13.05 Hanger/ support numbers shall be marked on all pipe supports, anchors, hangers, snubbers and restraint assemblies. Each constant and variable spring support shall also have stamped upon it the designed hot and cold load which it is intended to support. Suitable scale shall also be provided to indicate load on support/hanger.

8.13.06 Valves, steam traps and strainers shall be identified by BHEL/OWNER's tag number of a metal tap permanently attached to non pressure parts such as the yoke by a stainless steel wire. The direction of flow shall also be marked on the body.

- 8.13.07 Safety and relief valves shall be provided with the following :
- (a.) Manufacturer's identification.
 - (b.) Nominal inlet and outlet sizes in mm.
 - (c.) Set pressure in Kg/cm² (abs).
 - (d.) Blowdown and accumulation as percentage of set pressure.
 - (e.) Certified capacity in Kg of saturated steam per hour or in case of liquid certified capacity in litres of water per minute.
- 8.13.08 All such plates, instruction plates, etc. shall be bilingual with Hindi inscription first, followed by English. Alternatively, two separate plates one with Hindi and the other with English inscriptions may be provided.
- 8.13.09 All segregated phases of conductors or bus ducts, indoor or outdoor, shall be provided with coloured phase plates to clearly identify the phase of the system

8.14.00 Tools and Tackles

The Bidder shall supply with the equipment one complete set of all special tools and tackles and other instruments required for the erection, assembly, disassembly and proper maintenance of the plant and equipment and systems (including software). These special tools will also include special material handling equipment, jigs and fixtures for maintenance and calibration / readjustment, checking and measurement aids etc. A list of such tools and tackles shall be submitted by the Bidder alongwith the offer.

The price of each tool / tackle shall be deemed to have been included in the total bid price. These tools and tackles shall be separately packed and sent to site. The Bidder shall also ensure that these tools and tackles are not used by him during erection, commissioning and initial operation. For this period the Bidder should bring his own tools and tackles. All the tools and tackles shall be of reputed make acceptable to the BHEL/OWNER.

8.15.00 Welding

- 8.15.01 If the manufacturer has special requirements relating to the welding procedures for welds at the terminals of the equipment to be performed by others the requirements shall be submitted to the BHEL/OWNER in advance of commencement of erection work.

8.16.00 Colour Code for all Equipment/ Pippings/ Pipe Services

- 8.16.01 All equipment/ piping/ pipe services are to be painted by the Bidder in accordance with BHEL/OWNER's standard colour coding scheme, which will be furnished to the Bidder during detailed engineering stage.

8.17.00 Protection and Preservative Shop Coating

8.17.01 Protection

All coated surfaces shall be protected against abrasion, impact, discoloration and any other damages. All exposed threaded portions shall be suitably protected with either metallic or a nonmetallic protection device. All ends of all valves and piping and conduit equipment connections shall be properly sealed with suitable devices to protect them from damage. The parts which are likely to get rusted, due to exposure to weather, should also be properly treated and protected in a suitable manner. All primers/paints/coatings shall take into account the hot humid, corrosive & alkaline, subsoil or overground environment as the case may be.

8.17.02 Preservative Shop Coating

All exposed metallic surfaces subject to corrosion shall be protected by shop application of suitable coatings. All surfaces which will not be easily accessible after the shop assembly, shall be treated beforehand and protected for the life of the equipment. All surfaces shall be thoroughly cleaned of all mill scales, oxides and other coatings and prepared in the shop. The surfaces that are to be finish-painted after installation or require corrosion protection until installation, shall be shop painted with atleast two coats of primer.

Transformers and other electrical equipment if included shall be shop finished with one or more coats of primer and two coats of high grade epoxy. The finished colors shall be as per manufacturer's standards, to be selected and specified by the BHEL/OWNER at a later date.

8.17.03 Shop primer for all steel surfaces which will be exposed to operating temperature below 95 degrees Celsius shall be selected by the Bidder after obtaining specific approval of the BHEL/OWNER regarding the quality of primer proposed to be applied. Special high temperature primer shall be used on surfaces exposed to temperature higher than 95 degrees Celsius and such primer shall also be subject to the approval of the Owner.

8.17.04 All other steel surfaces which are not to be painted shall be coated with suitable rust preventive compound subject to the approval of the Owner.

8.17.05 All piping shall be cleaned after shop assembly by shot blasting or other means approved by the Owner. Lube oil piping or carbon steel shall be pickled.

8.17.06 Painting for Civil structures shall be done as per relevant part of technical specification.

9.00.00 QUALITY ASSURANCE PROGRAMME

9.01.00 The Bidder shall adopt suitable quality assurance programme to ensure that the equipment and services under the scope of contract whether manufactured or performed within the Bidder's works or at his sub-Bidder's premises or at the Owner's site or at any other place of work are in accordance with the specifications. Such programs shall be outlined by the Bidder and shall be finally accepted by the Owner/authorized representative after discussions before the award of the contract. The QA programme shall be generally in line with IS/ISO-9001. A quality assurance programme of the Bidder shall generally cover the following:

- (a.) His organization structure for the management and implementation of the proposed quality assurance programme
- (b.) Quality System Manual
- (c.) Design Control System
- (d.) Documentation and Data Control System
- (e.) Qualification data for bidder's key personnel.
- (f.) The procedure for purchase of materials, parts, components and selection of sub-Bidder's services including vendor analysis, source inspection, incoming raw-material inspection, verification of materials purchased etc.
- (g.) System for shop manufacturing and site erection controls including process, fabrication and assembly.
- (h.) Control of non-conforming items and system for corrective actions and resolution of deviations.
- (i.) Inspection and test procedure both for manufacture and field activities.
- (j.) Control of calibration and testing of measuring testing equipment.
- (k.) System for Quality Audits.
- (l.) System for identification and appraisal of inspection status.
- (m.) System for authorising release of manufactured product to the Owner.
- (n.) System for handling, storage and delivery.
- (o.) System for maintenance of records, and
- (p.) Quality plans for manufacturing and field activities detailing out the specific quality control procedure adopted for controlling the quality characteristics relevant to each item of equipment/component.

9.02.00 **General Requirements - Quality Assurance**

9.02.01 All materials, components and equipment covered under this specification shall be procured, manufactured, erected, commissioned and tested at all the stages, as per a comprehensive Quality Assurance Programme. An indicative programme of inspection/tests to be carried out by the Bidder for some of the major items is given in the respective technical specification. This is, however, not intended to form a comprehensive programme as it is the Bidder's responsibility to draw up and implement such programme duly approved by the Owner. The detailed Quality Plans for manufacturing and field activities shall be drawn up by the Bidder and will be submitted to Owner for approval. Schedule of finalisation of such quality plans will be finalised before award. Monthly progress reports on MQP/FQP submission/approval shall be furnished.

- 9.02.02 Manufacturing Quality Plan will detail out for all the components and equipment, various tests/inspection, to be carried out as per the requirements of this specification and standards mentioned therein and quality practices and procedures followed by Bidder's/ Sub-Bidder's/ sub-supplier's Quality Control Organisation, the relevant reference documents and standards, acceptance norms, inspection documents raised etc., during all stages of materials procurement, manufacture, assembly and final testing/performance testing. The Quality Plan shall be submitted on electronic media e.g. Compact Disc or E-mail in addition to hard copy, for review and approval. After approval the same shall be submitted in compiled form on CD-ROM.
- 9.02.03 Field Quality Plans will detail out for all the equipment, the quality practices and procedures etc. to be followed by the Bidder's "Site Quality Control Organisation", during various stages of site activities starting from receipt of materials/equipment at site.
- 9.02.04 The Bidder shall also furnish copies of the reference documents/plant standards/acceptance norms/tests and inspection procedure etc., as referred in Quality Plans along with Quality Plans. These Quality Plans and reference documents/standards etc. will be subject to Owner's approval without which manufacturer shall not proceed. These approved documents shall form a part of the contract. In these approved Quality Plans, Owner shall identify customer hold points (CHP), i.e. test/checks which shall be carried out in presence of the Owner's Project Manager or his authorised representative and beyond which the work will not proceed without consent of Owner in writing. All deviations to this specification, approved quality plans and applicable standards must be documented and referred to Owner along with technical justification for approval and dispositioning.
- 9.02.05 No material shall be despatched from the manufacturer's works before the same is accepted, subsequent to predespatch final inspection including verification of records of all previous tests/inspections by Owner's Project Manager/Authorised representative and duly authorised for despatch by issuance of Material Despatch Clearance Certificate (MDCC).
- 9.02.06 All material used for equipment manufacture including casting and forging etc. shall be of tested quality as per relevant codes/standards. Details of results of the tests conducted to determine the mechanical properties; chemical analysis and details of heat treatment procedure recommended and actually followed shall be recorded on certificates and time temperature chart. Tests shall be carried out as per applicable material standards and/or agreed details.
- 9.02.07 The Bidder shall submit to the Owner Field Welding Schedule for field welding activities in the format No.: QS-01-QAI-P-02/F3 to be issued at contract stage.
- 9.02.08 All welding and brazing shall be carried out as per procedure drawn and qualified in accordance with requirements of ASME Section IX/BS-4870 or other International equivalent standard acceptable to the Owner.

All welding/brazing procedures shall be submitted to the Owner or its authorised representative for approval prior to carrying out the welding/brazing.

- 9.02.09 All brazers, welders and welding operators employed on any part of the contract either in Bidder's/sub-Bidder's works or at site or elsewhere shall be qualified as per ASME Section-IX or BS-4871 or other equivalent International Standards acceptable to the Owner.
- 9.02.10 Welding procedure qualification & Welder qualification test results shall be furnished to the Owner for approval. However, where required by the Owner, tests shall be conducted in presence of Owner/authorised representative.
- 9.02.11 For all pressure parts and high pressure piping welding, the latest applicable requirements of the IBR (Indian Boiler Regulations) shall also be essentially complied with. Similarly, any other statutory requirements for the equipment/systems shall also be complied with. On all back-gauged welds MPI/LPI shall be carried before seal welding.
- 9.02.12 Unless otherwise proven and specifically agreed with the Owner, welding of dissimilar materials and high alloy materials shall be carried out at shop only.
- 9.02.13 No welding shall be carried out on cast iron components for repair.
- 9.02.14 All the heat treatment results shall be recorded on time temperature charts and verified with recommended regimes.
- 9.02.15 All non-destructive examination shall be performed in accordance with written procedures as per International Standards, The NDT operator shall be qualified as per SNT-TC-1A (of the American Society of non-destructive examination). NDT shall be recorded in a report, which includes details of methods and equipment used, result/evaluation, job data and identification of personnel employed and details of co-relation of the test report with the job.

All plates of thickness above 40mm & all bar stock/Forging above 40mm dia shall be ultrasonically tested. For pressure parts, plate of thickness equal to or above 25mm shall be ultrasonically tested.

- 9.02.16 The Bidder shall list out all major items/ equipment/ components to be manufactured in house as well as procured from sub-contractors bought out items (BOI). All the sub-Bidder proposed by the Bidder for procurement of major bought out items including castings, forging, semi-finished and finished components/equipment etc., list of which shall be drawn up by the Bidder and finalised with the Owner, shall be subject to Owner's approval. The Bidder's proposal shall include vendor's facilities established at the respective works, the process capability, process stabilization, QC systems followed, experience list, etc. along with his own technical evaluation for identified sub-contractors enclosed and shall be submitted to the Owner for approval within the period agreed at the time of pre-awards discussion and identified in review category prior to any procurement. Monthly progress reports on sub-Bidder detail submission / approval shall be furnished. Such vendor approval shall not relieve the Bidder from any obligation, duty or responsibility under the contract.

- 9.02.17 For components/equipment procured by the contractors for the purpose of the contract, after obtaining the written approval of the Owner, the Bidder's purchase specifications and inquiries shall call for quality plans to be submitted by the suppliers. The quality plans called for from the sub-Bidder shall set out, during the various stages of manufacture and installation, the quality practices and procedures followed by the vendor's quality control organisation, the relevant reference documents/standards used, acceptance level, inspection of documentation raised, etc. Such quality plans of the successful vendors shall be finalised with the Owner and such approved Quality Plans shall form a part of the purchase order/contract between the Bidder and sub-Bidder. Within three weeks of the release of the purchase orders /contracts for such bought out items /components, a copy of the same without price details but together with the detailed purchase specifications, quality plans and delivery conditions shall be furnished to the Owner on the monthly basis by the Bidder along with a report of the Purchase Order placed so far for the contract.
- 9.02.18 Owner reserves the right to carry out quality audit and quality surveillance of the systems and procedures of the Bidder's or their sub-Bidder's quality management and control activities. The Bidder shall provide all necessary assistance to enable the Owner carry out such audit and surveillance.
- 9.02.19 The Bidder shall carry out an inspection and testing programme during manufacture in his work and that of his sub-Bidder's and at site to ensure the mechanical accuracy of components, compliance with drawings, conformance to functional and performance requirements, identity and acceptability of all materials parts and equipment. Bidder shall carry out all tests/inspection required to establish that the items/equipment conform to requirements of the specification and the relevant codes/standards specified in the specification, in addition to carrying out tests as per the approved quality plan.
- 9.02.20 Quality audit/surveillance/approval of the results of the tests and inspection will not, however, prejudice the right of the Owner to reject the equipment if it does not comply with the specification when erected or does not give complete satisfaction in service and the above shall in no way limit the liabilities and responsibilities of the Bidder in ensuring complete conformance of the materials/equipment supplied to relevant specification, standard, data sheets, drawings, etc.
- 9.02.21 For all spares and replacement items, the quality requirements as agreed for the main equipment supply shall be applicable.
- 9.02.22 Repair/rectification procedures to be adopted to make the job acceptable shall be subject to the approval of the Owner/ authorised representative.
- 9.02.23 Burn in and Elevated Temperature Test Requirement for Electronics Solid State Equipment
- All solid state electronic systems/equipment shall be tested as a complete system/equipment with all devices connected for a minimum of 168 hours (7 Days) continuously under energized conditions prior to shipment from manufacturing works, as per the following cycle.

Elevated Temperature Test Cycle

During the elevated temperature test which shall be for 48 hours of the total 168 hours of testing, the ambient temperature shall be maintained at 50 deg.C. The equipment shall be interconnected with devices which will cause it to repeatedly perform all operations it is expected to perform in actual service with load on various components being equal to those which will be experienced in actual service.

During the elevated temperature test the cubicle doors shall be closed (or shall be in the position same as they are supposed to be in the field) and inside temperature in the zone of highest heat dissipating components/modules shall be monitored. The temperature rise inside the cubicle should not exceed 10 deg.C above the ambient temp. at 50 deg.C.

Burn in Test Cycle

The 48 hours elevated temperature test shall be followed by 120 hours of burn in test as above except that the temperature shall be reduced to the ambient temperature prevalent at that time.

During the above tests, the process I/O and other load on the system shall be simulated by simulated inputs and in the case of control systems, the process which is to be controlled shall also be simulated. Testing of individual components or modules shall not be acceptable.

In case the Bidder/ sub-Bidder is having any alternate established procedure of eliminating infant mortile components, the detail procedures followed by the Bidder/ sub- Bidder along with the statistical figures to validate the alternate procedure to be forwarded.

The Bidder/Sub-Bidder shall carry out routine test on 100% item at Bidder/sub-Bidder's works. The quantum of check/test for routine & acceptance test by Owner shall be generally as per criteria/sampling plan defined in referred standards. Wherever standards have not been mentioned quantum of check/test for routine / acceptance test shall be as agreed during detailed engineering stage.

9.03.00 QA Documentation Package

The Bidder shall be required to submit the QA Documentation in two hard copies and two CD ROMs, as identified in respective quality plan with tick (?) mark.

9.03.01 Each QA Documentation shall have a project specific Cover Sheet bearing name & identification number of equipment and including an index of its contents with page control on each document.

The QA Documentation file shall be progressively completed by the Supplier's sub-supplier to allow regular reviews by all parties during the manufacturing.

The final quality document will be compiled and issued at the final assembly place of equipment before despatch. However CD-Rom may be issued not later than three weeks.

9.03.02 Typical contents of QA Documentation is as below:-

(a.) Quality Plan

- (b.) Material mill test reports on components as specified by the specification and approved Quality Plans.
 - (c.) Manufacturer / works test reports/results for testing required as per applicable codes and standard referred in the specification and approved Quality Plans.
 - (d.) Non-destructive examination results /reports including radiography interpretation reports. Sketches/drawings used for indicating the method of traceability of the radiographs to the location on the equipment.
 - (e.) Heat Treatment Certificate/Record (Time- temperature Chart)
 - (f.) All the accepted Non-conformance Reports (Major/Minor) / deviation, including complete technical details / repair procedure).
 - (g.) CHP / Inspection reports duly signed by the Inspector of the Owner and Bidder for the agreed Customer Hold Points.
 - (h.) Certificate of Conformance (COC) wherever applicable.
 - (i.) MDCC
- 9.03.03 Similarly, the Bidder shall be required to submit two sets (two hard copies and two CD ROMs), containing QA Documentation pertaining to field activities as per Approved Field Quality Plans and other agreed manuals/ procedures, prior to commissioning of individual system.
- 9.03.04 Before despatch / commissioning of any equipment, the Supplier shall make sure that the corresponding quality document or in the case of protracted phased deliveries, the applicable section of the quality document file is completed. The supplier will then notify the Inspector regarding the readiness of the quality document (or applicable section) for review.
- (a.) If the result of the review carried out by the Inspector is satisfactory, the Inspector shall stamp the quality document (or applicable section) for release.
 - (b.) If the quality document is unsatisfactory, the Supplier shall endeavor to correct the incompleteness, thus allowing to finalize the quality document (or applicable section) by time compatible with the requirements as per contract documents. When it is done, the quality document (or applicable section) is stamped by the Inspector.
 - (c.) If a decision is made despatch, whereas all outstanding actions cannot be readily cleared for the release of the quality document by that time. The supplier shall immediately, upon shipment of the equipment, send a copy of the quality document Review Status signed by the Supplier Representative to the Inspector and notify of the committed date for the completion of all outstanding actions & submission. The Inspector shall stamp the quality document for applicable section when it is effectively completed. The submission of

QA documentation package shall not be later than 3 weeks after the despatch of equipment.

9.03.05 Transmission Of QA Documentation

On release of QA Documentation by Inspector, one set of quality document shall be forwarded to Corporate Quality Assurance Department and other set to respective Project Site of Owner.

For the particular case of phased deliveries, the complete quality document to the Owner shall be issued not later than 3 weeks after the date of the last delivery of equipment.

9.04.00 Project Manager's Supervision

9.04.01 To eliminate delays and avoid disputes and litigation, it is agreed between the parties to the Contract that all matters and questions shall be referred to the Owner's Project Manager and without prejudice to the provisions of 'Arbitration' clause in Section General Conditions of Contract, the Bidder shall proceed to comply with the Project Manager's decision.

9.04.02 The work shall be performed under the supervision of the Project Manager. The scope of the duties of the Project Manager pursuant to the Contract, will include but not be limited to the following:

- (a.) Interpretation of all the terms and conditions of these documents and specifications:
- (b.) Review and interpretation of all the Bidder's drawing, engineering data, etc:
- (c.) Witness or his authorised representative to witness tests and trials either at the manufacturer's works or at site, or at any place where work is performed under the contract :
- (d.) Inspect, accept or reject any equipment, material and work under the contract.
- (e.) Issue certificate of acceptance and/or progressive payment and final payment certificates
- (f.) Review and suggest modifications and improvement in completion schedules from time to time, and
- (g.) Supervise Quality Assurance Programme implementation at all stages of the works.

9.05.00 Inspection, Testing And Inspection Certificates

9.05.01 The word 'Inspector' shall mean the Project Manager and/or his authorized representative and/or an outside inspection agency acting on behalf of the Owner to inspect and examine the materials and workmanship of the works during its manufacture or erection.

- 9.05.02 The Project Manager or his duly authorized representative and/or an outside inspection agency acting on behalf of the Owner shall have access at all reasonable times to inspect and examine the materials and workmanship of the works during its manufacture or erection and if part of the works is being manufactured or assembled on other premises or works, the Bidder shall obtain for the Project Manager and for his duly authorized representative permission to inspect as if the works were manufactured or assembled on the Bidder's own premises or works.
- 9.05.03 The Bidder shall give the Project Manager/Inspector fifteen (15) days written notice of any material being ready for testing. Such tests shall be to the Bidder's account except for the expenses of the Inspector's. The Project Manager/Inspector, unless the witnessing of the tests is virtually waived and confirmed in writing, will attend such tests within fifteen (15) days of the date on which the equipment is noticed as being ready for test/inspection failing which the Bidder may proceed with test which shall be deemed to have been made in the inspector's presence and he shall forthwith forward to the inspector duly certified copies of test reports in two (2) copies.
- 9.05.04 The Project Manager or Inspector shall within fifteen (15) days from the date of inspection as defined herein give notice in writing to the Bidder, or any objection to any drawings and all or any equipment and workmanship which is in his opinion not in accordance with the contract. The Bidder shall give due consideration to such objections and shall either make modifications that may be necessary to meet the said objections or shall inform in writing to the Project Manager/Inspector giving reasons therein, that no modifications are necessary to comply with the contract.
- 9.05.05 When the factory tests have been completed at the Bidder's or sub-Bidder's works, the Project Manager /Inspector shall issue a certificate to this effect fifteen (15) days after completion of tests but if the tests are not witnessed by the Project Manager /Inspectors, the certificate shall be issued within fifteen (15) days of the receipt of the Bidder's test certificate by the Project Manager /Inspector. Project Manager /Inspector to issue such a certificate shall not prevent the Bidder from proceeding with the works. The completion of these tests or the issue of the certificates shall not bind the Owner to accept the equipment should it, on further tests after erection be found not to comply with the contract.
- 9.05.06 In all cases where the contract provides for tests whether at the premises or works of the Bidder or any sub-Bidder, the Bidder, except where otherwise specified shall provide free of charge such items as labour, material, electricity, fuel, water, stores, apparatus and instruments as may be reasonably demanded by the Project Manager /Inspector or his authorized representatives to carry out effectively such tests on the equipment in accordance with the Bidder and shall give facilities to the Project Manager/Inspector or to his authorized representative to accomplish testing.
- 9.05.07 The inspection by Project Manager / Inspector and issue of Inspection Certificate thereon shall in no way limit the liabilities and responsibilities of the Bidder in respect of the agreed Quality Assurance Programme forming a part of the contract.

- 9.05.08 To facilitate advance planning of inspection in addition to giving inspection notice as specified at clause no 9.05.03- of this chapter, the Bidder shall furnish quarterly inspection programme indicating schedule dates of inspection at Customer Hold Point and final inspection stages. Updated quarterly inspection plans will be made for each three consecutive months and shall be furnished before beginning of each calendar month.
- 9.05.09 All inspection, measuring and test equipment used by Bidder shall be calibrated periodically depending on its use and criticality of the test/measurement to be done. The Bidder shall maintain all the relevant records of periodic calibration and instrument identification, and shall produce the same for inspection by the Owner. Wherever asked specifically, the Bidder shall re-calibrate the measuring/test equipment in the presence of Project Manager/Inspector.
- 9.06.00 **Associated document for quality assurance programme:**
- 9.06.01 List of items requiring quality plan and sub supplier approval.
- 9.06.02 Status of items requiring Quality Plan and sub supplier approval.
- 9.06.03 Field Welding Schedule
- 9.06.04 Manufacturing Quality Plan
- 9.06.05 Field Quality Plan
Format for the above shall be issued at Contract stage.

10.00.00 PRE-COMMISSIONING AND COMMISSIONING FACILITIES

- (a.) As soon as the facilities or part thereof has been completed operationally and structurally and before start-up, each item of the equipment and systems forming part of facilities shall be thoroughly cleaned and then inspected jointly by the Owner and the Bidder for correctness of and completeness of facility or part thereof and acceptability for initial pre-commissioning tests, commissioning and start-up at Site. The list of pre-commissioning tests to be performed shall be as mutually agreed and included in the Bidder's quality assurance programme as well as those included elsewhere in the Technical Specifications.
- (b.) The Bidder's pre-commissioning/ commissioning/start-up engineers, specially identified as far as possible, shall be responsible for carrying out all the pre-commissioning tests at Site. On completion of inspection, checking and after the pre-commissioning tests are satisfactorily over, the commissioning of the complete facilities shall be commenced during which period the complete facilities, equipment shall be operated integral with sub-systems and supporting equipment as a complete plant.

It will be the responsibility of the Bidder to assess and furnish a list of all commissioning spares required for successful commissioning of all the equipment covered under the contract. Such a list shall be

furnished by the Bidder within 12 months from the date of LOA, separately for each equipment and shall be reviewed by the Owner and discussed for mutual agreement. The commissioning spares will be so identified as not to allow the trial operation to suffer for want of such commissioning spares. The identification of commissioning spares will not in any way relieve the Bidder of any of his responsibilities of satisfactory performance under the provisions of other conditions of contract. All the commissioning spares shall be deemed to be included in scope of the Bidder as a part of the respective equipment package at no extra cost to the Owner.

- (c.) NA
- (d.) The time consumed in the inspection and checking of the units shall be considered as a part of the erection and installation period.
- (e.) The check outs during the pre - commissioning period should be programmed to follow the construction completion schedule. Each equipment/system, as it is completed in construction and turned over to Owner's commissioning (start-up) Engineer(s), should be checked out and cleaned. The checking and inspection of individual systems should then follow a prescribed commissioning documentation [SLs (Standard Check List) / TS (Testing Schedule) / CS (Commissioning Schedule)] approved by the Owner.
- (f.) The Bidder during initial operation and performance testing shall conduct vibration testing to determine the 'base line' of performance of all plant rotating equipment. These tests shall be conducted when the equipment is running at the base load, peak load as well as lowest sustained operating condition as far as practicable.
- (g.) Bidder shall furnish the commissioning organization chart for review & acceptance of Owner at least eighteen months prior to the schedule date of synchronization of 1st unit. The chart should contain :
 - (1.) Biodata including experience of the Commissioning Engineers.
 - (2.) Role and responsibilities of the Commissioning Organisation members.
 - (3.) Expected duration of posting of the above Commissioning Engineers at site.

10.02.00 Initial Operation

- a) On completion of all pre-commissioning activities / tests and as a part of commissioning the complete facilities shall be put on 'Initial Operation' during which period all necessary adjustments shall be made while operating over the full load range enabling the facilities to be made ready for the Guarantee Tests.
- b) The 'Initial Operation' of the complete facility as an integral unit shall be conducted for 720 continuous hours. During the period of initial operation

- of 720 hours, the unit shall operate continuously at full rated load for a period not less than 72 hours.
- c) The Initial Operation shall be considered successful, provided that each item/ part of the facility can operate continuously at the specified operating characteristics, for the period of Initial Operation with all operating parameters within the specified limits and at or near the predicted performance of the equipment/ facility.
 - d) The Bidder shall intimate the Owner about the commencement of initial operation and shall furnish adequate notice to the Owner in this respect.
 - e) Any loss of generation due to constraints attributable to the Owner shall be construed as Deemed Generation.
 - f) An Initial Operation report comprising of observations and recordings of various parameters to be measured in respect of the above Initial Operation shall be prepared by the Bidder. This report, besides recording the details of the various observations during initial operation shall also include the dates of start and finish of the Initial Operation and shall be signed by the representatives of both the parties. The report shall have sheets, recording all the details of interruptions occurred, adjustments made and any minor repairs done during the Initial Operation. Based on the observations, necessary modifications/repairs to the plant shall be carried out by the Bidder to the full satisfaction of the Owner to enable the latter to accord permission to carry out the Guarantee tests on the facilities. However, minor defects which do not endanger the safe operation of the equipment, shall not be considered as reasons for withholding the aforesaid permission.

10.03.00 **Guarantee Tests**

- a) The final test as to prove the Functional Guarantees shall be conducted at Site by the Bidder in presence of the Owner. The Bidder's Commissioning, Start-up Purchaser shall make the unit ready to conduct such test. Such test will be commenced and completed as per schedule.
- b) These tests shall be binding on both the parties of the Contract to determine compliance of the equipment with the functional guarantee.
- c) For performance/ demonstration tests instrumentations, of accuracy class, to the approval of the Owner shall be used. The numbers and location of the instruments shall be as per the specified test codes. In addition the values of parameters shall be logged from the information system provided under Owner's Distributed Digital Control Monitoring and Information system. Test will be conducted at specified load points.
- d) Any special equipment, tools and tackles required for the successful completion of the Guarantee Tests shall be provided by the Bidder, free of cost.
- e) The Guarantee tests and specific tests to be conducted on equipment have been brought out in detail elsewhere in the specification.

11.00.00 **TAKING OVER**

Upon successful completion of Initial Operations and all the tests other than guarantee tests conducted to the Owner's satisfaction, the Owner shall issue to the Bidder a Taking over Certificate as a proof of the final acceptance of the equipment. Such certificate shall not unreasonably be withheld nor will the Owner delay the issuance thereof, on account of minor omissions or defects which do not affect the commercial operation and/or cause any serious risk to the equipment. Such certificate shall not relieve the Bidder of any of his obligations which otherwise survive, by the terms and conditions of the Contract after issuance of such certificate.

12.00.00 TRAINING OF OWNER'S PERSONNEL

12.01.00 The scope of service under training of Owner shall include a training module in the areas of Operation & Maintenance.

Such training should cover the following areas as a minimum in order to enable these personnel to individually take the responsibility of operating and maintaining the power station in a manner acceptable to the Owner:

(a.) Training for Electric Power Supply systems

The above training shall be provided taken by the Bidder in one of the reference power plant.

12.02.00 The scope of services under training shall also necessarily include training of Owner's Engineering personnel covering a training module of upto 2 man months. This shall cover all disciplines viz, Mechanical, Electrical, C&I, & QA etc. and shall include all the related areas like Design familiarization, training on product design features and product design softwares of major equipment and systems, engineering, manufacturing, erection, commissioning, training on operating features of equipment, quality assurance and testing, plant visits and visits to manufacturer's works, exposure to various kinds of problems which may be encountered in fabrication, manufacturing, erection, welding etc. An indicative module of the training requirement of Owner's Engineering personnel is attached as Annexure-I (BOQ).

12.03.00 Bidder shall furnish in his offer, details of training module(s) covering above requirements which shall be subject to Owner's approval. Consolidated training period included above (i.e. 1 and 2 man months respectively for O&M and Engineering) is indicative only. Owner reserves the right to reappropriate the training period between O&M and engineering depending upon the details of training module proposed by the Bidder.

12.04.00 Refer Annexure-II for detailed scope of services under Training.

12.05.00 Exact details, extent of training and the training schedule shall be finalised based on the Bidder's proposal within two (2) months from placement of award.

12.06.00 In all the above cases, wherever the training of Owner's personnel is arranged at the works of the manufacturer's it shall be noted that the lodging and boarding of the Owner's personnel shall be at the cost of Bidder. The Bidder shall make all necessary arrangements towards the same.

- 12.07.00 Take off prices (product wise) should be indicated by the Bidder in the Bid Proposal Sheets. Owner reserves the right to include or exclude these item(s) during place of Award. All expenses except travelling expenses shall be borne by the contractor.

13.00.00 SAFETY ASPECTS DURING CONSTRUCTION AND ERECTION

In addition to the requirements given in Erection Conditions of Contract (ECC) the following shall also cover:

- (a.) Working platforms should be fenced and shall have means of access.
- (b.) Ladders in accordance with Owner's safety rules for construction and erection shall be used. Rungs shall not be welded on columns. All the stairs shall be provided with handrails immediately after its erection.

14.00.00 NA

15.00.00 PACKAGING AND TRANSPORTATION

All the equipment & spares shall be suitably protected, coated, covered or boxed and crated to prevent damage or deterioration during transit, handling and storage at Site till the time of erection. Each spare shall be clearly marked or labeled on the outside of the packing with its description. When more than one spare part is packaged in a single case, a general description of the contents shall be shown on the outside of such a case and other packages must be suitably marked and numbered for the purpose of identification. All cases, containers or packages, are liable to be opened for such examination as may be considered reasonable by the Engineer. In case of equipment supplied with grease/lubricants from imported origin, the supplied shall clearly indicate the indigenous equivalent of the grease/lubricant and source of supply so as to enable the Owner to procure these items from indigenous sources. While packing all the materials, the limitation from the point of view of the sizes of railway wagons available in India should be taken account of. The Bidder shall be responsible for any loss or damage during transportation, handling and storage due to improper packing. The Bidder shall ascertain the availability of Railway wagon sizes from the Indian Railways or any other agency concerned in India well before effecting dispatch of equipment. Before dispatch it shall be ensured that complete processing and manufacturing of the components is carried out at shop, only restricted by transport limitation, in order to ensure that site works like grinding, welding, cutting & pre-assembly to bare minimum. The Owner's Inspector shall have right to insist for completion of works in shops before dispatch of materials for transportation.

- Manufacturer shall furnish detailed Packing list before dispatch of material
- Master Packing List for complete list of Equipment or Material to be furnished to BHEL for this project during detailed Engineering Stage.

The Packed item shall have Marking Plate with following details on Packing:

	BHEL-TBG-Noida-India
NAME OF ITEM	
CONSIGNEE	
MATERIAL	
CUSTOMER REF.	
DESPATCH ADVICE NOTE NO.	
DIMENSIONS (MM) LXBXH	
NET WEIGHT (KG)	
GROSS WEIGHT (KG)	
SPECIAL INSTRUCTIONS	HANDLE WITH CARE – KEEP DRY DO NOT DROP – DO NOT TILT (or manufacturer's instructions)
MO. NO.	
CASE NO.	

16.00.00 ELECTRICAL ENCLOSURE

All electrical equipment and devices, including insulation, heating and ventilation devices shall be designed for ambient temperature and a maximum relative humidity as specified elsewhere in the specification.

17.00.00 INSTRUMENTATION AND CONTROL

All instrumentation and control systems/ equipment/ devices/ components, furnished under this contract shall be in accordance with the requirements stated herein, unless otherwise specified in the detailed specifications.

17.01.00 All instrument scales and charts shall be calibrated and printed in metric units and shall have linear graduation. The ranges shall be selected to have the normal reading at 75% of full scale.

All scales and charts shall be calibrated and printed in Metric Units as follows:

a)	Temperature	-	Degree centigrade (deg C)
b)	Pressure	-	Kilograms per square centimeter (Kg/cm ²). Pressure instrument shall have the unit

			suffixed with 'a' to indicate absolute pressure. If nothing is there, that will mean that the indicated pressure is gauge pressure.
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17.02.00 All instruments and control devices provided on panels shall be of miniaturized design, suitable for modular flush mounting on panels with front draw out facility and flexible plug-in connection at rear.

17.03.00 All electronic modules shall have gold plated connector fingers and further all input and output modules shall be short circuit proof. These shall also be tropicalized & components shall be of industrial grade or better.

18.00.00 ELECTRICAL NOISE CONTROL

The equipment furnished by the Bidder shall incorporate necessary techniques to eliminate measurement and control problems caused by electrical noise. Areas in Bidder's equipment, which are vulnerable to electrical noise shall be hardened to eliminate possible problems. Any additional equipment, services required for effectively eliminating the noise problems shall be included in the proposal. The equipment shall be protected against ESD as per IEC-801- 2. Radio Frequency interference (RFI) and Electro Magnetic Interference (EMI) protection against hardware damage and control system mal-operations/errors shall be provided for all systems.

19.00.00 NA

20.00.00 TAPPING POINTS FOR MEASUREMENTS

Tapping points shall include probes, wherever applicable, for analytical measurements and sampling.

For direct temperature measurement of all working media, one stub with internal threading of approved pattern shall be provided along with suitable plug and washer. The Bidder will be intimated about thread standard to be adopted.

The following shall be provided on equipment by the Bidder. The standard which is to be adopted, will be intimated to the Bidder.

- (a.) Temperature test pockets with stub and thermowell
- (b.) Pressure test pockets

21.00.00 ELECTRONIC MODULE/COMPONENT DETAILS

The Bidder shall have to furnish all technical details including circuit diagrams, specifications of components, etc., in respect of each and every electronic card/module as employed on the various solid state as well as microprocessor based systems and equipment including conventional instruments, peripherals etc.

It is mandatory for the Bidder to identify clearly the custom built ICs used in the package. The Bidder shall also furnish the details of any equivalents of the same.

22.00.00 ENVIRONMENTAL MONITORING & CONTROL MEASURES

Bidder to note that MOEF has declared Manali area as critically polluted area and also imposed certain restrictions on consideration of developmental projects.

Concerned authorities have been addressed to have self monitoring system (for Air, Water & Land) so as to ascertain the level of compliance of standards prescribed by MOEF and also to furnish the action plan ie., for the establishment of self monitoring system. It is also directed to undertake Environmental Audit (EA) to ascertain the compliance level of standards notified by MOEF.

CHAPTER - 3

PAINTING

1.0 SCOPE

This section defines the technical requirements for surface preparation, selection and application of paints on equipment, vessels, machinery, piping, ducts etc. However, manufacturers shall follow their standard procedures for painting their equipment. The bidder shall submit a detailed painting procedure for approval of owner/ owner's representative after the award of contract.

The following surface and material shall require painting:

- a. All un-insulated carbon steel and alloy steel equipment like columns, vessels, storage tanks, pumps, heat exchangers etc.
- b. All un-insulated carbon steel and low alloy piping, fitting and valves (including painting of identification marks).
- c. All pipe structural steel supports, walkways, platforms, handrails, ladders etc.

The following surfaces and materials shall not require painting :

- a. Non-ferrous materials
- b. Austentic stainless steel
- c. Plastic and / or plastic coated materials
- d. Insulated surface of equipment and pipes except color coating wherever required.
- e. Painted equipment like blowers, pumps, valves etc. with finishing coats in good condition and with matching color code.

2.0 CODES AND STANDARDS

Painting of equipment shall be carried out as per the specifications indicated below and shall conform to the relevant IS specification for the material and workmanship.

The following Indian Standards may be referred to for carrying out the painting job :

IS:5	:	Colours for ready mixed paints and enamels
IS:1303	:	Glossary of terms relating to paints
IS:2379	:	Colour code for identification of pipelines
IS:1477	:	Code of practice for painting of ferrous metals in buildings (Parts I & II)
IS:2524	:	Code of practice for painting of non-ferrous metals in buildings (Parts I & II)
IS:2395	:	Code of practice for painting of concrete, masonry and plaster surfaces (Parts I & II)
IS:2338	:	Code of practice for finishing of wood and wood based materials (Parts I & II)

IS:158	:	Ready mixed paint, brushing, bituminous, black, lead free, acid, alkali, water and heat resisting.
IS:2074	:	Ready mixed paint, air drying, red Oxide Zinc Chrome, priming
IS:104	:	Ready mixed paint, brushing, Zinc Chrome, priming
IS:2932	:	Enamel Synthetic exterior (a) Undercoating (b) finishing
IS:4682	:	Code of practice for lining of vessels & equipment
SIS 559000	:	Swedish standard for blasting
ISO 8504-2	:	Preparation of steel substrates before application of paints and related products. Surface preparation methods Part 2 Abrasive blast cleaning
ISO 8501-1	:	Preparation of steel substrates before application of paints and related products. Visual assessment of surface cleanliness. Part 1 : Rust grades and preparation grades of uncoated steel substrates and of steel substrates after overall removal of previous coatings.
SIS 05 5800	:	Surface preparation by acid pickling
SSPC SP08	:	Surface preparation by acid pickling
IS 2629	:	Recommended practice for hot dip galvanizing of iron and steel
ASTM A780	:	Standard practice for repair of damaged galvanized coatings
SSPC	:	Steel structures painting council
NACE	:	National association of Corrosion Engineers
DIN	:	Deutsehes Institute for Normung
BS	:	British Standard
ASTM	:	American Society for Testing material
AWWA	:	American Water works association

3.0 SURFACE PREPARATION

The surface shall be prepared in a manner suitable for coatings. Chemical derusters or rust converters shall not be applied. Acid cleaning is subject to approval of Purchaser/ Purchaser's representative.

3.1 BLASTING

The surface of the part/ component shall be blasted before the coating material is applied.

Compressed air supply for blast cleaning shall be free of water and oil. Air compressors shall not be allowed to deliver air above 1100C. Blasting activity shall be performed at temperatures 30C above dew point and substrata temperature between 50C & 500C and relative humidity not exceeding 85% shall be maintained during painting. Necessary safety precautions for equipment and operator shall be adhered to and shall comply with applicable laws, regulations, ordinances etc., of the local authority, state or the nation pertains to the work.

Abrasive used for blast cleaning carbon steel and alloy steel shall be as per ISO 8504-2 and SSPC painting manual. Suggested abrasives are chilled iron grit, shot steel, malleable iron grit and shots of non metallic abrasive (aluminum oxide, copper slag, garnet etc.).

The grade of blasting shall be performed in line with the approved painting scheme.

The nature, quality and grain size of abrasives and the parameter of their use are to be chosen to obtain the required surface profile depth and cleanliness.

Surfaces prepared for coating shall be coated the same day and before any visible rusting occurs (the time elapsed between blast cleaning and commencement of painting shall under no circumstances exceed 4 hours, but in any case must commence before signs of degradation occur).

The grades of surface finish

	ISO 8501-1	SIS 055900	SSPC	NACE
White metal	Sa3	Sa3	SP5	1
Near White metal	Sa 2½	Sa 2½	SP10	2
Commercial Blast	Sa2	Sa2	SP6	3
Brush off blast	Sa1	Sa1	SP7	4

Unless otherwise specified in the documents, the surface shall satisfy the following requirements after blasting

(a) Blasting according to SIS 055900, Grade Sa 2½

Primer paint shall be Zinc Silicate of approved brand. Dry film thickness of each primer coat shall be 15-25 µm.

3.2 Manual Rust Removal

Manual rust removal shall be allowed for welded zones and for touching up installed components.

3.3 Cleaning

Removal of impurity

	Impurity	Removal
a)	Dust, Loose deposits	Vacuum cleaning, brushing
b)	Adhesive deposits	Power brushing
c)	Oils, greasy impurities	Wet Blasting, Use of Detergent Additives by agreement
d)	Salt deposits	Rinsing
e)	Markings (eg felt up pen)	Organic solvents to manufacturer's specifications eg Trichloro trifluoro ethane and solvents containing acetone (renew solvent and rag frequently)

3.4 Acid Pickling

Prior to galvanizing the surface preparation shall be done by acid pickling as per SSPC-SP-08.

4.0 PROCESSING

4.1 General

Application Conditions

The primer shall be applied to properly prepared surfaces only. The specifications of the coating material manufacturers shall be observed. The minimum temperature shall be + 5°C and the relative humidity shall not exceed 80%. The temperature of the work piece shall be at least 3°C above dew point.

4.2 Application Procedure

The primer shall be applied by means of brush or by spary. The top coats shall be applied by means of brush, roller or spray.

At points where coating application is interrupted, the individual layers shall be adequately stepped to ensure proper layer sequence when coating operations are resumed.

4.3 Touching Up

Before each layer is applied, previous coating shall be touched up where necessary by way of rust removal and cleaning according coating manufacturers specification. The final top shall be reapplies completely.

4.4 Uncoated Surfaces

Moving parts of machines (e.g stems, shafts, sliding and locating bearings), nameplates, instruments and sealing surface shall not be coated. Welds shall be left free of coating upto a distance of 30 mm on each side of the weld edge until erection and weld examinations, if any, have been completed.

4.5 Bond Strength

The pill off stress determined using the pull off test method for adhesion shall not be less than 1.5 N/mm², according to ISO 4624.

5.0 SURFACE CONDITIONS OF COATING SURFACES

The coating surface shall have a uniform film thickness, shade and gloss and shall be free from inclusions, sags and wrinkles.

6.0 COATING SYSTEMS

6.1 General Requirements for Coating Systems

Coating materials according to SSPC, BS 5493 or DIN 55 928 shall be used. Intermediate coats are to be pigmented with micaceous iron oxide. The materials shall be matched with each other so that they are compatible. Coatings deviating this specification shall be subject to approval. Standards of surface preparation and painting shall give a time to first maintenance of 10 years.

The colour and gloss of top coats shall be in accordance with sub clause suggested colour codes for painting (Sub Clause 6.8)

6.2 Standard Coating System (External Coatings)

(a) Steel Surfaces

- (i) All steel structures shall receive two primer coats and two sandwich coat of MIO Epoxy paint and one finish coat of painting. First coat of primer shall be given in shop after fabrication before dispatch to erection site after surface preparation as described below. The second coat of primer shall be applied after erection and

final alignment of the erected structures. Two intermediate coats and one finished coat shall also be applied after erection.

- (ii) Steel surface which is to be painted shall be cleaned of dust and grease and the heavier layers of rust shall be removed by chipping prior to actual surface preparation. The surface shall be abrasive blasted as explained in clause 3.1 to Sa 2½ finish as per SIS05-5900. Primer paint shall be Zinc Silicate of approved brand. Dry film thickness of each primer shall be 60 microns.
- (iii) Two intermediate MIO Epoxy paint, and one top polyurethane coating of approved brand shall be applied. Dry film thickness of each intermediate coat shall be 90 microns and top polyurethane coating shall be 30 microns. The under coat and finish coat shall be of different tint to distinguish the same from finish paint. The total dry film thickness shall be 330 microns. All paints shall be of approved brand and shade as per owner's requirement.
- (iv) Joints to be site welded shall have weldable primer applied within 100 mm of welding zone. Similarly where friction grip fasteners are to be used removable anti corrosive coating shall be provided. On completion of the joint the surfaces shall receive the paint as specified.
- (v) Surfaces inaccessible after assembly shall receive two coats of primer prior to assembly. Surfaces inaccessible after erection including top surfaces of floor beams, supporting gratings or chequered plate shall receive one additional coat of finish paint over the above number of coats specified before erection. Portion of steel member embedded/ to be encased in concrete shall not be painted.

(b) Gratings and Step Threads

(i) Surface Preparation

Gratings and step threads shall be cleared by acid pickling as per SSPC-SP-08

(ii) Hot Dip galvanizing

The hot dip galvanizing shall be done as per IS 2629. The average mass of coating shall be 610 gm/m².

(iii) Post Treatment

Immediately after galvanizing post treatment such as chromating shall be applied to retard white rust attack.

(iv) Touch up mechanical damages

The repair of damages coatings shall be done as per the recommended practice ASTM A780.

CHAPTER 4

DRAWING DOCUMENT SUBMISSION

4.1 DISCREPANCIES BETWEEN DRAWING AND SPECIFICATION:

Should there be any discrepancy between the specifications and/or schedule of prices and/or drawings or any inconsistency, error or omission in either of them, reference must be made to the BHEL/CUSTOMER for an explanation and the Supplier will be held responsible for any errors that may occur in the work through neglect of this precaution. The explanation of the BHEL/CUSTOMER shall be final and binding on the Supplier.

4.2 APPROVAL PROCEDURE

The scheduled dates for the submission of drawings as well as for, any data/information to be furnished by the Employer would be as per the following schedule. The supplier shall also submit required no. of copies as mentioned in this specification of all drawings/design documents/test reports for approval by the Employer. The following schedule shall be followed generally for approval.

i.	First Submission	Within 7 days from the date of LOI/PO
ii.	Approval/comments/by employer on Initial submission	Reasonable time
iii.	Resubmission	Within 7 days (whenever from date of comments required) Including both ways postal time.
iv.	Approval or comments	Within 2 weeks of receipt of resubmission.
v.	Furnishing of distribution copies	2 weeks from the date of last approval.

Note: The supplier may please note that all resubmissions must incorporate, all comments given in the submission by the Employer failing which the submission of documents is likely to be returned. Every revision shall be a revision number, date and subject, in a revision block provided in the drawing, clearly marking the changes incorporated.

The title block of drawings shall contain the following information incorporated in all contract drawings. Please refer enclosed sheet for details of Title block.

4.3 TITLE BLOCK

Following Title Blocks to be used in drawings at the time of drawing approvals

Project:	400kV GIS at 2 x 660 MW Ennore SEZ Supercritical Thermal Power Project at Ash Dyke of NCTPS, Chennai-120		
NOA No:	CE/P/SE/M/P/EE-10/E/P/F.2X660MW	ENNORE	SEZ
Customer :	TAMILNADU GENERATION AND DISTRIBUTION CORPORATION (TANGEDCO)		
Consultant	DESEIN PRIVATE LIMITED, NEW DELHI		
Contractor	BHARAT HEAVY ELECTRICALS LIMITED		

4.4 DOCUMENTS TO BE SUBMITTED ALONG WITH OFFER

- 1) Drawings
- 2) Guaranteed Technical Particulars
- 3) Type Test Reports
- 4) List of Part Supplies with rating

Drawings & Documents submitted at the time of offer shall be subject to review at contract stage.

4.5 DOCUMENTATION SCHEDULE

Following Documentation schedule to be followed per project.

S. No.	DESCRIPTION	TENDER STAGE	CONTRACT STAGE FOR APPROVAL	FINAL DOCUMENTATION	
			Hard Copy / Prints	Hard Copy / Prints	CDs
1	Drawings and Data Sheets	1	7	10	5
2	Drawings "As Built "	-	-	10	
3	Type Test Reports	1	7	10	
4	Erection Manuals	-	7	10	
5	Operation and Maintenance Manuals	-	7	10	
6	Manufacturing Quality Plan	-	7	10	
7	Field Quality Plan	-	7	10	

8	Inspection Test Reports	-	7	10	

Supplier to submit Hard copies of the drawing to following address

To,
<Name of BHEL's concerned engineering official>
Bharat Heavy Electricals Limited
Transmission Business Group- Engineering Management
Advant Navis IT Business Park
Plot No.-7, Greater Noida Expressway,
Sector 142, **NOIDA**, Uttar Pradesh 201305

Note: Drawings will also be submitted in CD/DVD in Latest AUTOCAD version or any other CAD package along with conversion files for all major items.

Final Documentation shall be submitted in bound volumes with details of Customer & Project etc. written on top.

SECTION -4

**GUARANTEED TECHNICAL PARTICULARS OF CABLES
(TO BE SUBMITTED BY SUCCESSFUL BIDDER)**

1.0 General

1.1 Name of manufacturer :

1.2 Place of Manufacture :

2.0 Standards applicable`

2.1 **IS: 7098 Part-II** :

For general specification of XLPE Cables

2.2 **IS: 8130** :

For conductor material

2.3 **IS: 5831** :

For material of innersheath & outersheath.

2.4 **IS: 3975 / IS: 8130** :

For armour of 3 core/ single core cables

2.5 **IS: 10810** :

For method of tests

2.6 **IS:10418** :

For cable drums

2.7 **ASTMD-2863** :

For oxygen index test

2.8 **SS:424-1475 & IEC-332-III-Cat-A,
IEC-332-I/ IEEE: 383** :

For flammability test

2.9 **IEC-754-1** :

For acid gas generation test

2.10 **ASTMD-2843** :

For smoke generation test

2.11 Current rating of cables conforms to :

- hr/>
- 2.12 Short circuit rating conforms to :
- 2.13 Formula for calculating short circuit current for different durations :
- 3.0 (a) Installation Conditions at site
- i) ambient air temperature : deg. C
- ii) ground temperature : deg. C
- iii) Depth of laying of cables buried in ground : cm
- iv) thermal resistivity of soil : deg. C cm/W
- (b) Installation conditions for current rating specified at clause 6.3 :
- 4.0 **CHARACTERISTICS OF FRLS SHEATH**
- a) Oxygen index :
- b) Temperature index :
- c) Acid gas generation :
- d) Smoke density rating :
- 5.0 **CABLE DRUMS**
- a) Type & construction :
- b) Standard drum length :
- c) Tolerance on drum length :
- 6.0 **INFORMATION TO BE FILLED IN FOR EACH SIZE CABLE IN THE FORM OF TABLE**
- 6.1 No. of cores x size :
- 6.2 Voltage grade (U_0/U) : kV
- 6.3 Base current ratings (*) based on Clause 3.0
- a) In air : Amp
- b) In ground : Amp
- c) ducts : Amp
- 6.4 Short circuit rating : kA, sec.
- 6.5 a) D.C. resistance of conductor at : ohm/km

20 deg. C

- | | | |
|---|---|--------|
| b) A.C. resistance of conductor at 90 deg. C | : | ohm/km |
| c) Reactance of cable at normal frequency | : | ohm/km |
| d) Electrostatic capacitance of cable at normal frequency | : | mF/km |

6.6 CONDUCTOR

- | | | |
|--|---|---------|
| a) Material type & grade | : | |
| b) No & dia of wires in each core before stranding | : | no x mm |
| c) Shape | : | |

6.7 CONDUCTOR SCREEN

- | | | |
|----------------------|---|--|
| a) Material | : | |
| b) Minimum thickness | : | |

6.8 XLPE INSULATION

- | | | |
|------------------------------------|---|----|
| a) Nominal thickness of insulation | : | mm |
| b) Method of curing | : | |

6.9 INSULATION SCREEN

- | | | |
|---|---|----------|
| a) Material and thickness (minimum and nominal) | | |
| i) Metallic | : | |
| No. of tapes and minimum overlapping | : | |
| ii) Non-metallic | : | |
| b) Earth fault current withstand capacity (Calculation to be furnished) | : | kA, sec. |

6.10 PVC ST2 INNERSHEATH

- | | | |
|--------------------------|---|-------------------|
| a) Material | : | |
| b) Thickness (min.) | : | mm |
| c) Method of application | | |
| 1) Multi-core cables | | |
| i) With fillers | : | |
| ii) With out fillers | : | Pressure Extruded |
| 2) Single core cables | : | |

- d) Type & Shape of fillers (if used) :
- e) Colour
- 6.11 ARMOUR
- (a) Material :
- b) Size/ dimensions :
- c) Minimum no. of wires/ formed wires :
- d) Tolerance on formed wire dimension :
- e) Maximum resistivity of GS formed wire :
- f) Maximum resistivity of Al round wire :
- g) Minimum coverage :
- 6.12 PVC ST2 FRLS OUTERSHEATH
- a) Nominal thickness of outer sheath : mm
- 6.13 Diameters
- a) Diameter of insulated conductor : mm
- b) Diameter of laid up core : mm
- c) Cable diameter under armour : mm
- d) Cable diameter over armour : mm
- e) Overall diameter of cable : mm
- 6.14 Tolerance on overall diameter : (±) mm
- 6.15 Minimum bending radius : x O.D.
- 6.16 Safe pulling force : kg.
- 6.17 Weight of cable : kg./km
- (a) Weight of conductor : MT./km
- (b) Weight of XLPE insulation : MT./km
- (c) Weight of PVC (Inner Sheath, Outer Sheath & Fillers) : kg./km
- (d) Weight of Armour (As applicable) : kg./km
- 6.18 Reel indicating the length, type, voltage grade,
 Conductor size and number of core of the cable :
- 6.19 Dimension of drum : mm
- 6.20 Shipping weight : kg.
- 6.21 Cable marking on outer sheath :

- (*) For single core cables, the continuous current rating shall be furnished separately for armour earthed at one end and at both ends.
- (*) Eccentricity and Ovality also to be indicated.

GURANTEED TECHNICAL PARTICULARS OF CABLE ACCESSORIES
(TO BE SUBMITTED BY SUCCESSFUL BIDDER)
(SEPARATE FOR EACH TYPE & SIZE OF CABLE)

1.0.0 GENERAL

- 1.1.0 Name of manufacturer:
- 1.2.0 Place of manufacture:

2.0.0 Standard Applicable:

IS: 13573/ VDE 0278 for testing of kits:

3.0.0 TECHNICAL DETAILS

3.1.0 TERMINATION KITS

- a) Make:
- b) Type:
- c) Application: Outdoor
- d) Voltage Grade:
- e) Kit no. as per catalogue:
- f) Applicable conductor size:
- g) Whether previously type tested/ within past five years:
- h) Shelf life of the least durable component: years
- i) Tinned Copper heavy duty type cable lugs
Form part of termination kits: Yes
- j) Total shrouding of all live parts: Yes

3.2.0 STRAIGHT THROUGH JOINTS

- a) Make:
- b) Type:
- c) Voltage Grade:
- d) Kit no. as per catalogue:
- e) Applicable conductor size:
- f) Whether previously type tested within past five years:
- g) Shelf life of the least durable component: years

CHECK LIST

1. TECHNICAL REQUIREMENTS FOR 33 KV XLPE CABLE

Sl.	Particulars	Reply by bidder.	
1	TECHNICAL QUALIFYING REQUIREMENT		
1.1	Papers for qualifying requirement enclosed. Submit the same along with tabulated annexure for review of qualifying claim.	Confirmed	Yes/No
1.2	The bid shall be submitted by the Manufacturer of the 33 kV Cable. Bids submitted by agents will not be considered.	Confirmed	Yes/No
1.3	All the documents shall be submitted in English. Translated pages should be attested by the bidder.	Confirmed	Yes/No
2	Un-priced Offer –.		
2.1	Confirm that all items have been quoted. (If any item has not been quoted, the same shall be specifically brought out in Schedule of Technical Deviation)	Confirmed	Yes/No
3	Cable Lengths		
3.1	Confirm to supply of cables as per section-1	Confirmed	Yes/No
3.2	Cables shall be supplied in non-returnable wooden or steel drums of heavy construction. The surface of the drum and the outer most cable layer shall be covered with water proof cover. Both the ends of the cables shall be properly sealed with heat shrinkable PVC/ rubber caps secured by 'U' nails so as to eliminate ingress of water during transportation, storage and erection. Wood preservative anti-termite treatment shall be applied to the entire drum. Wooden drums shall comply with IS: 10418.	Confirmed	Yes/No
4	Technical		
4.1	Technical Deviations		
4.1.1	Confirm that the cable has been offered as per the requirements of Technical Specification and Technical Deviation sheet has been submitted. Deviations mentioned elsewhere in the bid will not be considered.	Confirmed	Yes/No
4.1.2	Technical Deviation sheet has been submitted.	Confirmed	Yes/No
5	Bar chart		
5.1	Bidder will submit detailed bar chart indicating all the milestones from Engineering till manufacturing/ testing, dispatch to site.	Confirmed	Yes/No
7	INSPECTION & TESTING		
7.1	Inspection and Testing shall be as approved Quality Plan.	Confirmed	Yes/No

CONSTRUCTION DETAILS

S.NO.	ITEM	PARTICULARS	Confirmation Yes / No	Remark
8	REFERENCE STANDARD	IS-7098 PART-II IN GENERAL	YES / NO	
9	SYSTEM VOLTAGE	33 KV	YES / NO	
10	VOLTAGE GRADE OF CABLES	19 / 33 KV (E)	YES / NO	
11	CONDUCTOR			
	a. REFERENCE STANDARD	IS-8130	YES / NO	
	b. MATERIAL	ALUMINUM H2 GRADE CLASS 2	YES / NO	
	c. SHAPE	MULTI-STRANDED COMPACTED CIRCULAR - THE ECCENTRICITY OF THE CORE SHALL NOT EXCEED 10% AND OVALITY NOT TO EXCEED 2%	YES / NO	
	d. SIZES (NO. OF CORES -CROSS- SECTIONAL AREA)	500 Sqmm, Single Core	YES / NO	
12	CONDUCTOR SCREENING	EXTRUDED SEMI-CONDUCTING COMPOUND MINIMUM THICKNESS: 0.8 MM	YES / NO	
13	INSULATION			
	a. REFERENCE STANDARD	IS-7098 PART-II	YES / NO	
	b. MATERIAL	EXTRUDED XLPE	YES / NO	
14	INSULATION SCREENING			
	a. REFERENCE STANDARD	IS-7098 PART -II	YES / NO	
	b. MATERIAL			
	(i) NON METALLIC	EXTRUDED SEMI-CONDUCTING COMPOUND MINIMUM THICKNESS: 0.8 MM	YES / NO	
	(ii) METALLIC	THE METALLIC SCREEN OF EACH CORE SHALL CONSIST OF COPPER TAPE WITH MINIMUM OVERLAP OF 20%. NON-MAGNETIC METALLIC CU TAPE PER CORE SIZED FOR CARRYING EARTH FAULT CURRENT OF 300A FOR 1 SEC. MINIMUM THICKNESS: 0.1 MM	YES / NO	
15	EXTRUSION (INSULATION AND			

		SCREENS)			
	a.	PROCESS	TRIPLE EXTRUSION. (EXTRUDED SEMI-CONDUCTING COMPOUND FOR CONDUCTOR SCREEN AND INSULATION SCREEN SHALL BE APPLIED ALONG WITH XLPE INSULATION IN A SINGLE OPERATION BY TRIPLE EXTRUSION DRY CURE PROCESS USING NITROGEN).	YES / NO	
	b.	METHOD OF CURING	DRY CURING USING NITROGEN	YES / NO	
16		CORE IDENTIFICATION	NOT APPLICABLE	YES / NO	
17		INNER SHEATH			
	a.	REFERENCE STANDARD	IS-5831 & IS-7098 PART II	YES / NO	
	b.	MATERIAL	EXTRUDED HRPVC, FR-LSH CONFORMING TO TYPE ST2	YES / NO	
	b.1.	FILLERS (IF APPLICABLE)	ACCEPTABLE	YES / NO	
	b.2.	MATERIALS OF FILLERS	SAME AS INNER SHEATH	YES / NO	
18		ARMOUR			
	a.	REFERENCE STANDARD	IS- 3975, IS- 7098 PART II & IS 8130	YES / NO	
	b.	SINGLE CORE CABLES			
	b.1.	MATERIAL	NON-MAGNETIC HARD DRAWN ALUMINIUM GRADE H4	YES / NO	
	b.2.	SHAPE	ROUND WIRE	YES / NO	
19		SHORT CIRCUIT WITHSTAND CAPACITY			
	a.	CONDUCTOR	25KA FOR 3 SEC	YES / NO	
	b.	COPPER TAPE SCREENING	300 A for 1 Sec	YES / NO	
	c.	ARMOUR	25KA FOR 1 SEC	YES / NO	
20		OUTER SHEATH			
	a.	REFERENCE STANDARD	IS-5831 & IS-7098 PART II	YES / NO	
	b.	MATERIAL	EXTRUDED HRPVC, FR-LSH CONFORMING TO TYPE ST2	YES / NO	
21		CHARACTER TICS OF HRPVC, FR-LSH SHEATH			

	a.	OXYGEN INDEX	MIN. 29% (AS PER ASTM D 2863)	YES / NO	
	b.	TEMPERATURE INDEX	MIN. 250°C AT OXYGEN INDEX OF 21 (AS PER ASTM D 2863)	YES / NO	
	c.	ACID GAS GENERATION	MAX 20% (AS PER IEC 60754-1)	YES / NO	
	d.	SMOKE DENSITY RATING	MAX 60% (AS PER ASTM D 2843)	YES / NO	
22		DRUM LENGTH			
	a.	DRUM LENGTH	CABLE DRUM LENGTH TO SUIT CROSS BONDING ARRANGEMENT I.E. DIVISION TO CIRCUIT LENGTH IN MULTIPLES OF THREE. TENTATIVE DRUM LENGTH IS 600 METER AND THE SAME WILL BE FINALIZED DURING DETAILED ENGINEERING.	YES / NO	

Remark – SL 6 is blank

Name & Signature of Authorised Representative

with company seal

Date:

Place:

Phone:

Fax:

E-mail:

Mobile:

Website:

ANNEXURE - A
SCHEDULE OF TECHNICAL DEVIATIONS

Bidder shall list below all technical deviation clause wise w.r.t. tender specifications:

S.No.	Page No.	Clause No.	Deviation	Reason / Justification
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Any deviation not specifically brought out in this section shall not be admissible for any commercial implication at later stage. Except to the technical deviations listed in this schedule, bidder's offer shall be considered in full compliance to the tender specifications irrespective of any such deviation indicated / taken elsewhere in the submitted offer.

Date:

Tenderer's Stamp & Signature