

ANNEXURE X
Micro Small and Medium Enterprises (MSE) – Clause for NIT

In line with Gazette notification issued by Ministry of Micro Small and medium enterprises on MSE suppliers, the following special provisions shall be applicable.

20% of the tendered quantity is earmarked for MSE suppliers in this tender.

Out of the 20% tendered quantity reserved for MSE suppliers, 4% shall be earmarked for procurement from MSE owned by SC / ST entrepreneurs.

In case MSE vendor participating in the tender quotes within the price band of LI + 15%, they will be allowed to supply the portion of the requirement subject to acceptance of LI price by MSE vendor. In case of more than one such MSE, the supply shall be shared proportionately.

In case of tender items is not-splitable or non-dividable etc., MSE quoting price within the price band L1+15% may be awarded for full/complete supply of total tendered value to MSE

MSE suppliers can avail the intended benefits only if they submit along with the offer, attested copies of either

1. EM II certificate having deemed validity (two years from the date of issue of acknowledgement in EM II) **or**
2. Valid NSIC certificate or EM II certificate along with CA certificate (Format enclosed) applicable for the year, certifying quantum of investment in plant and machinery within the permissible limits as per the act for relevant status (MICRO or SMALL) where the deemed validity of EM II is over.

Date to be reckoned for determining the deemed validity will be the last date of technical bid submission (Part 1 in case of two part bid).

Non submission of such documents will lead to consideration of their bid at par with other bidders and MSE status of such suppliers shall be shifted to NON MSE suppliers till the supplier submit this documents.

Documents should be notarized or attested by a Gazetted officer.

Definitions of MSEs owned by SC/ST is under:

- ***In case of proprietorship firm, proprietor must be SC/ST.***
- ***In case of partnership firm, the SC/ST partners must be holding at least 51% shares in the unit.***
- ***In case of private limited companies, at least 51% share must be held by SC/ST promoters.***

Authorised Offices to Issue SC/ST certificate.

The caste/Tribe/Community certificate issued by the following authorities in the prescribed form for SCs/STs can be considered.

- District Magistrate/Additional District Magistrate/Collector/Deputy commissioner/Additional Deputy commissioner/Deputy collector/1st class stipendary magistrate/Sub divisional Magistrate/Taulka Magistrate/Executive magistrate/Extra Assistant commissioner.
- Chief Presidency magistrate/Additional chief presidency magistrate/Presidency magistrate.
- Revenue Officer not below the rank of thasildar.
- Sub-Divisional officer of the area where the individual and / or his family normally resides.

To avail the benefits of MSE under SC/ST category, the related documents as stated above should be submitted along with tender documents.

BHARAT HEAVY ELECTRICALS LIMITED, TIRUCHIRAPPALLI - 620 014
CONTROLS AND INSTRUMENTATION / FB



TECHNICAL SPECIFICATION FOR ONLINE CARBON IN ASH
ANALYSER SYSTEM

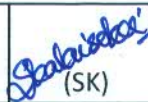
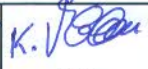
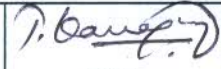
TAMIL NADU GENERATION AND DISTRIBUTION CORPORATION LIMITED

ENNORE SEZ SUPERCRITICAL THERMAL POWER PROJECT

(2X660 MW)

CUSTOMER Nos. 1723 & 1724

SPECIFICATON NUMBER: TDC:TCI:337/ Rev 00

00	30/06/17	Initial Release	 (SK)	 (KV)	 (VA)	 (TK)
REV. NO.	DATE	DESCRIPTION	PREPARED	ENGG	QAC	APPROVED
				REVIEWED		

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1.0 GENERAL INSTRUCTIONS TO VENDORS:

- 1.1 Vendor to check receipt of complete documents referred to in the 'Contents'. In the event of order, the entire specification will form part of purchase order for compliance during execution.
- 1.2 Deviation if any shall be clearly brought out in the "Deviation format". In case of no deviation, vendor shall fill 'NIL' in the format, authenticated and furnished along with the offer.
- 1.3 Nothing in this specification shall be construed to relieve the vendor from his responsibility. The specification covers briefly the requirement of online carbon in ash analyser System. It is the responsibility of the vendor to take care of other basic and essential requirements for the offered system.

2.0 Pre-Qualification requirement

- 2.1 The offered system shall have a record of trouble free performance of minimum two (2) year in min 1 (one) nos. coal-fired boiler of size 500 MW or above where the firing arrangement is similar to the offered boiler.
- 2.2 Commissioning and service support for the offered system shall be available in India.

The above pre-qualification requirement is mandatory for technical offer evaluation. Pre-Qualification requirement shall be furnished by the vendor during offer submission as per the format given in annexure I.

3.0 SCOPE

3.1 The scope of work includes design, engineering, manufacturing, fabrication, assembly, painting, inspection, Factory Acceptance Test, packing, supply, integrating the system at Project site (along with loose components / modules in case of loose supply of the same) with the supplied system peripherals, Erection supervision, Commissioning (inclusive of Travel fares & accommodation of the engineers/ technicians), Calibration, carrying out Site Acceptance Test and proving the performance of the system. The system shall fully comply with this specification for meeting the entire functional and operational requirement.

3.2 The scope of supply of equipment includes, but not limited to the following:

- a. One no. Carbon in ash analyser system per Steam Generator, along with all accessories for on line continuous monitoring of unburnt carbon in ash based on microwave technology shall be provided at Economiser / air heater / ESP hopper / ducts (The location shall be finalized during detailed engineering).
- b. Any modifications required for installing vendor's equipment in the existing ducts or hopper to be in vendor's scope.

- c. Provision for shifting the measurement location (e.g from one hopper to a nearby hopper) shall be feasible and involve only minimum modification.
- d. Necessary measurement probes, control cabinet, isolation valves, solenoid valves, root valves, piping, Copper-tubing, air filter regulator, instruments, hoses etc. as required shall be provided by the bidder.
- e. Bidder shall supply all the necessary hardware, cables and connector for the subject package & associated system in their scope.
- f. Required field and control cabinets.
- g. All required interconnecting cables, including power cables, from sensor to field cabinet, field cabinet to control cabinet and control cabinet to DCS (4-20mA as well as RS 485). Cable specification as per Annexure-III.
- h. HMI (Industrial grade LCD display) to provide the required user interface.
- i. Commissioning Spares required for successful commissioning and handing over of the system shall be included in the offer.
- j. All items, both hardware and software, as required to make the system complete shall be included.
- k. It is to be specifically noted by the vendor that the responsibility of proving and fulfilling the functional requirements of the system solely rests with the vendor.

3.3 The Vendor shall provide all material, equipment and services so as to make a totally integrated System together with all accessories and associated equipment's ensuring operability, maintainability and reliability. This work shall be consistent with modern power plant practices and shall be in compliance with all applicable codes, standards, guides, statutory regulations and safety requirements in force.

3.4 Vendor shall also include in his proposal and shall furnish all equipment, devices and services which may not be specifically stated in the specification but are needed for completeness of the equipment/systems furnished by the Vendor and for meeting the intent and requirements of the specification.

3.5 The input power supply source of 230VAC, Single phase, 50 Hz at single point (control cabinet) will be provided. Further distribution of power is in the scope of vendor. The vendor shall indicate the power required in wattage for the system. Other utilities like instrument air, service air etc., if required, shall be provided by purchaser at a single location. Further distribution shall be in the scope of vendor.

3.6 Substitutions: Should, in the performance of the work, the Bidder finds it necessary or desirable to make a substitution for either material or function, he shall request permission to make the substitution in writing. No substitution shall be made without the written approval of purchaser (BHEL).

- 3.7 If any up-gradation of the offered system is envisaged before completion of the job to meet the specified requirements, the same shall be incorporated in the system, with the approval of the Purchaser (BHEL) without any additional cost.
- 3.8 Vendor shall supply items required as per specification and demonstrate the performance to the customer. In case the vendor is not able to demonstrate the system performance to the satisfaction of customer, the same shall be taken back by vendor. All required procedures and formalities for taking back the equipment shall be the responsibility of vendor without any cost implication to the purchaser.

4.0 FUNCTIONAL REQUIREMENTS

4.1 Application

Online carbon in fly ash analyser system along with all required accessories for on line continuous monitoring of unburnt carbon in ash based on Microwave technology shall be provided at a suitable location. The location shall be finalized during detailed engineering. Further, provision shall be kept for installation of sensor in other location also.

4.2 System requirements

- (a)** The system shall utilize non sampling/extraction type microwave technology for online monitoring/measurement of the unburnt carbon in fly ash with minimum 4 nos. probes measurement to have complete profile per location.
- (b)** The system shall measure a fly ash at a representative location (The locations shall be decided & finalized by owner during detailed engineering)
- (c)** The error in measuring system shall not be more than 0.6% unburnt carbon in fly ash, which shall be demonstrated by comparisons with laboratory measurements.
- (d)** The measurement shall be updated atleast once in 15 minutes.
- (e)** In order to maximize the reliability the number of moving parts on the sensor shall be minimized.
- (f)** The measurement probes shall be suitably designed to meet continuous duty requirements in hot (up to 400 deg. C depending on location) & ash-laden environment and shall be with abrasion resistant material.
- (g)** The system shall also provide 4-20mA DC output (2 Nos.) for DDCMIS and thru redundant soft link RS485 compatible Modbus/Ethernet serial communication protocol. Output shall include potential free relay contacts for alarms, faults, etc.
- (h)** One feeder of 230 Volts +/- 10% at a single point (Vendor's control cabinet) shall be provided. Further distribution board and any other hardware shall be in bidder's scope.

- (i) The control cabinet shall be preferably mounted free standing in the CCR/CER which is 300m away. Necessary cooling arrangement shall be integral to the control cabinets located in field due to distance limitations.
- (j) System shall have provision to collect sample for laboratory analysis.
- (k) Electrical panel specifications refer section 5.0

5.0. CABINETS/ ENCLOSURES/ PANELS

All panels and enclosures shall be of free standing type and shall be constructed of specified gauge of steel plates. The panel sheet thickness shall be not less than 2 mm.

The panels shall be reinforced as required to ensure true surfaces and adequate support for instruments mounted thereon. All instrument cut-outs, mounting studs, and support brackets shall be accurately located. All welds on the exposed panel surfaces shall be ground smooth. Finished panel surfaces shall be free from waves, bellies, or other imperfections. Unless specified, otherwise, panel doors shall be 4 points hinged and shall have turned back edges and additional bracing where required to ensure rigidity. Door hinges shall be of the concealed type. Door latches shall be of the three-point type to ensure tight closing. Door locks shall be furnished which will allow actuation of all locks by a single master key. All panels shall have removable lifting eyebolts for safe lifting from top during storage and installation handling.

Cabinet doors shall be hinged and shall have turned back edges and additional bracing where required ensuring rigidity. Hinges shall be of concealed type. Door latches shall be of three point type to assure tight closing. Detachable lifting eyes or angles shall be furnished at the top of each separately shipped section and all necessary provisions shall be made to facilitate handling without damage. Front and rear doors shall be provided with locking arrangements with a master key for all cabinets. If width of a cabinet is equal or more than 800 mm, double doors shall be provided.

All panels shall be mounted on vibration dampers, which are secured to channels mounted on the floor. The channels shall be field welded to steel plates set into the concrete flooring. The steel plates shall be located such as to approximate the outline of panel bases. All panels shall be provided with adequate ventilation and packaging density of components shall be restricted so as to limit the temperature rise above ambient to 10°C under the worst conditions. All panels shall have auto on/off switch for internal lighting. All the power supply circuit for control panels shall be provided with auto changeover circuitry.

Exhaust Fans with louvers & filters shall be provided on door's (front & Rear) upper side to remove hot air in all panels.

Fire/Smoke detectors shall be provided inside the Control room mounted system/control cabinets.

UPS /non UPS's Feeder failure/ healthy indication shall be provided in each cabinet & remote indication shall be hooked up to DDCMIS/PLC/annunciation & suitably grouped.

All the panels shall be equipped with Anti vibration pad of min. 15 mm size. Cable gland plate thickness shall be 3 mm.

Doors shall be provided with neoprene/polyurethane gasket only.

All the cable entries shall be at the bottom of electronic cubicles/control panels.

The finish colours for exterior and interior surfaces shall conform to the following shades:

- a) Exterior - RAL 7032
- b) Interior - Glossy white two coats

Panels shall be provided with LED based illuminating lamps with door switch and six (6) point 6/16A, 240V AC universal type power sockets with switch for maintenance purposes. These switches shall be with quick make and break mechanism. 100 % spare LED lamps shall be provided with each panel, these are in addition to mandatory spares.

All panels and cabinets shall be provided with a continuous bare copper ground bus of minimum 6 mm x 25/50 mm cross section. The ground bus shall be bolted to the panel structure and effectively ground the entire structure. Each Ground bus shall have provision at each end for connection of ground leads (6 mm x 50 mm GI Flats) by suitable bolting. All system cabinets shall be brought to a common system ground by the bidder. Electronic earthing resistance shall be < 0.5 ohms.

Each circuit requiring grounding shall be individually and directly connected to the panel ground bus by ring tongue type compression lugs. For electronic system cabinets the system ground bus shall be insulated from the cabinet enclosure and shall be separately connected to the system ground. All system cabinets shall be brought to a common system ground by the bidder.

PROTECTION, CLASS OF CABINETS / PANELS, ENCL.OSURES ETC.

a) All panels, desks cabinets, consoles & enclosures furnished at least comply with the requirements of protection classes as indicated below.

- 1. In-door Air-conditioned (A.C.) areas - IP32/42 (min.)
- 2. In-door Non A.C. areas:
 - (a) Ventilated enclosures - IP42
 - (b) Non Ventilated. IP 54
- 3. Out-door IP65
 - b) Distribution boxes, junction boxes, cold junction compensation boxes, terminal boxes and all other field mounted equipment to be furnished as per this specification shall have weather protection conforming to IP 65.

- c) The design of panels, cabinets, enclosures and packaging density of components mounted therein shall be such that the temperature rise does not exceed 10 deg. C above the ambient under the worst conditions.
- d) The panels housing electronic hardware shall be provided with flame and smoke detectors by bidder.

5.1. Name plates / labels:

Panels shall be provided with clear engraved identification name plate for all the front mounted components. Name plate shall be 3.0 mm thick Non-Hygroscopic material engraved with white lettering. The inscription letter size shall be 15mm for Main name plate (inscribed as "Online Carbon in Ash Analyser system") and 3-5 mm for others. The labels for the components coming inside the panel shall be mounted directly below and shall be designated as per the circuit. Danger labels/ name plates shall be provided wherever necessary. Name plates shall be fixed by means of pan head screws or self-adhesive film.

5.2. Loose supply items:

Foundation bolts, double compression type cable glands for cables, cable lugs shall be supplied along with panel as loose supply items. This shall be listed separately in the packing list.

6.0. Factory Acceptance Test:

Authorization-to-ship-test (ATST) or Factory Acceptance Test (FAT) to be carried out in vendor works shall include all required tests to fully demonstrate to BHEL's and/or owner satisfaction that each equipment/sub-system/system as well as software modules furnished as per this specification fully meets the functional requirements of this specification.

7.0. SPECIAL INSTRUCTIONS

- 7.1 Vendor shall make visits to BHEL / Trichy for detailed engineering/discussion regarding location & mounting of sensors.
- 7.2 Vendor shall attend warranty / defect calls within 48 hours.
- 7.3 Vendor to supply the O & M manual in 'CD-ROM'

8.0. TRAINING

Training on the entire Software and Hardware of the offered Online Carbon in Ash analyser system shall be provided for a period not less than 4 man-days.

9.0. COMMISSIONING

The Complete responsibility of commissioning of the system lies with the vendor. All the commissioning Spares required for successful commissioning is in vendor scope. Vendor shall provide all services related to commissioning of the system supplied. After Commissioning of the system, Vendor's Engineer shall get the Protocols signed by the Owner of the plant and BHEL's site Engineer. After successful completion of Commissioning of the System, Vendor's Engineer shall get the Final Acceptance Protocol format signed by Owner and BHEL's site Engineer and furnish the signed copies to BHEL Tiruchi. Without this document, Vendor's responsibility for completion of the system and handing it over to Owner is not deemed to have been completed. Charges for vendor's visit to site towards commissioning and handing over of the system shall be included in the price. This shall be valid for the entire period of the contract.

Any spare parts / items required for the system during commissioning shall be provided by the vendor. Vendor's engineer shall bring adequate spares for commissioning of the system and non-availability of any item shall not hold up the progress of commissioning of the system in any way. Vendor shall also furnish list of spares required for successful commissioning of the system.

10.0. DOCUMENTATION

Following document shall be submitted along with the offer in Triplicate:

(The documents shall be neat, legible and in English)

- (a) Filled in datasheet.
- (b) Detailed system description/configuration/arrangement drawing, operational write-up with working principles, bill of materials, drawings, datasheets, information, technical catalogues, test certificates, material certificate, guarantee certificate, calibration certificate, characteristic curve (if applicable) and other detail as required to fully establish the capability and performance of the equipment and systems offered.
- (c) Complete BOM for the offered system. The BOM submitted shall contain the make, model number, rating of the item. The import and indigenous content shall clearly brought out in the offer.
- (d) Any previous factory acceptance test reports for a similar application qualifying the accuracy of the system with respect to laboratory measurement.
- (e) Power requirements, Air requirements (in Nm³/hr), details of accessories etc. required to establish product quality and scope of supply.
- (f) Schematic wiring drawing, general arrangement & Internal General Arrangement drawing of control panels.
- (g) Bill of materials for special cable and cable accessories (if any).
- (h) Signal exchange scheme with DDCMIS etc.
- (i) Filled in technical data sheets.

- (j) The break-up price for each component shall be furnished along with the offer, which shall be valid throughout the contract period.
- (k) Filled in "Deviation format" with reason / justification for the deviations taken.
- (l) Separate offer for recommended spares for two years Operation and Maintenance which shall be valid throughout the contract period.
- (m) List of Commissioning Spares required for successful commissioning and handing over of the system to the owner.
- (n) Requirement of electric power for utilities, service/ instrument air etc clearly defining continuous and intermittent requirement.
- (o) List of reference of similar system already in service.
- (p) All other documents not specifically mentioned here but required for completion of engineering work and proper coordination shall be unit wise.
- (q) Procedure for Factory acceptance test and Site acceptance test for purchaser's (BHEL) and owner's approval.
- (r) List and schedule of documents to be submitted by vendor for purchaser's (BHEL) and owner's approval / information after issue of Letter of intent(LOI).
- (s) List/description of various types of cable along with unit price.

Offer without the above documents will be considered as incomplete / non-responsive and liable for rejection.

Following documents shall be submitted after award of LOI

- 10.1. Vendor shall furnish a detailed list of documents along with the schedule for submission, after Letter of Intent (LOI) is awarded. This list shall be furnished along with the offer.
- 10.2. System OGA drawing, Bill of materials with make, model nos. and applicable literature/catalogues have to be furnished within 2 weeks from the date of LOI for Purchaser's (BHEL) approval. All drawings for approval shall be submitted in 3 hard copies in addition to 3 CD ROMs.
- 10.3. All final documents like GA drawing, data sheets of all components, internal arrangement drawings etc., shall be submitted in 3 CD ROMS in addition to 2 sets of hard copies.
- 10.4. After commissioning, if submitted drawings undergo any change, the same shall be revised suitably. The revised drawings referred to as 'AS BUILT' drawings shall be submitted in 3 CD ROMS in addition to 2 sets of hard copies.
- 10.5. All documents including drawings shall be in standard A4 or A3 size only.
- 10.6. All documents shall be in English, legible and neatly printed or typed.
- 10.7. Test report/ Test certificates: Vendor to furnish in 3 Sets

10.8. O&M Manuals:

- a. 2 sets of Operation & Maintenance manuals in hardcopy and softcopy (CD-ROM) for each category of equipment shall be submitted within one week from the date of inspection.
- b. The O&M manuals shall be with sufficient detail to enable the user to maintain, dismantle, reassemble and adjust all parts of the equipment. Step by step procedure for all operations likely to be carried out during the life of the plane/ equipment including erection, testing, commissioning, operation, maintenance, dismantling and repair.
- c. A collection of the manufacture's standard leaflets will not be acceptable. The O&M manual shall be specifically compiled for this project.
- d. Each manual shall also include a complete set of approved drawings together with performance/ rating curves of the equipment and test certificates wherever applicable.
- e. The O&M manual shall contain complete details about the system including the following:
 - (a) Applicable drawings
 - (b) Full details and drawings of all equipment furnished the testing, operations and maintenance procedures etc. separately on each equipment.
 - (c) Application software listing
 - (d) Relevant catalogues of all the modules / components used in the system
 - (e) Complete spare parts list, including ordering procedure and complete address(es) of spare part supplier(s)
 - (f) Storage instruction of components.
 - (g) Do's and Don'ts
 - (h) Testing and troubleshooting instructions.
 - (i) Programming manuals
 - (j) Any other details felt necessary by the Purchaser (BHEL) / owner.

11.0. SYSTEM DATA SHEETS

Vendor shall provide data sheets for the major components of the system offered. Vendor shall furnish full and complete technical particulars, specifications, catalogues, dimensional drawings for each component of the system offered for approval.

12.0. CARBON IN ASH ANALYSER SYSTEM SOFTWARE

Applicable Software shall be downloaded in the processors and in the programming / monitoring terminal. Such software shall also be supplied in “CD-ROM’s” in triplicate.

13.0. QUALITY ASSURANCE PROGRAM, INSPECTION AND TESTING

13.1. Quality Plan:

13.1.1 The vendor shall submit the quality plan in format which is enclosed (Annexure-I). Quality plan shall cover all major items in the System. Vendor shall indicate all checks done right from the raw material stage through bought out item, in process assembly, testing and final inspection of these items. For each characteristic, vendor should indicate the appropriate reference documents like national standards, international standards, drawing, etc. and a copy of vendor quality plan shall be submitted along with the offer for review. The functional tests shall be described in detail as “Factory Acceptance Test procedure” and shall be indicated under reference documents.

13.1.2 Vendor shall submit the above QP for BHEL & owners approval and the manufacture can start only after the QP is approved by BHEL & owner.

13.1.3 Where CHP (Customer Hold Point) is indicated in the approved QP, the vendor has to offer such item at that stage for inspection by BHEL & owner. The vendor can proceed further only when written clearance is obtained for that stage of CHP.

13.2. Type Test Requirements for Solid State Equipment

All solid state equipment shall be able to withstand the noise and surge inherent in a Power House, and shall strictly comply with SWC tests ANSI C 37.90A, 1974 for IEEE-472 (1974). Complete details of the features incorporated in electronic system to meet this requirement, the relevant test carried out, and the test certificates shall be submitted along with the proposal.

Electronic Cards, Subassemblies and Componets

a) Unpackaged

i) Vibration : IEC-68.2.6

ii) Shock : IEC-68.2.27

iii) Drop & Topple: IEC-68.2.31

b) Packaged

Vibration, Drop & Static Compression - NSTA

C) Electromagnetic Compatibility

- i) Electrical Fast Transient : IEC-801.4
- ii) Surge Withstand : IEC-255.4
- iii) Radiated Electromagnetic Field : IEC-801.3
- iv) Electrostatic Discharge : IEC-801.2
- v) Electromagnetic Emission : VDE 0871, Class B

Type tests

- 1. Enclosure test as per IS-2147
- 2. Surge withstand capability (SWC) test as per ANSI C37.90a IEEE-472 1974.
- 3. Damp heat cycling tests as per IS-2106 Part-II-1962 or equivalent international standards.
- 4. Noise immunity test

13.3 Inspection:

- 1. The complete system has to be offered for inspection by BHEL & Owner (wherever applicable) and the vendor shall give 30 days advance notice for arranging the inspection after the system is fully tested and ready.
- 2. After Inspection, the equipment can be despatched only after obtaining the MDCC (Material Despatch Clearance Certificate) from Owner. No material shall be despatched without MDCC.

14.0 PACKING:

The system should be packed with sea worthy packing.

Vendor shall be solely responsible for packing and marking of CARGO with respect to handling, transport, and storage at plant site. VENDOR shall be fully liable for proper, sufficient and adequate packing, completeness of contents, protection of contents for a storage time of minimum 2 years, and correct preparation of the packing list. All damage and costs whatsoever resulting from inadequate or insufficient packing shall be fully charged to vendor.

Packing and conservation of goods shall be sufficient to protect them from damage during transit from point of manufacturer and storage at job SITE under conditions which may involve multiple handling, extended storage, exposure to moisture and the possibility of pilferage.

15.0. LIST OF ANNEXURES

- 15.1 Annexure I -Pre-Qualification requirement Format
- 15.2 Annexure II -Quality Plan Format
- 15.3 Annexure III - Power & Instrumentation Cable Specification.

ANNEXURE I

Pre-Qualification
requirement Format

PRE QUALIFICATION REQUIREMENT

Item Description	ONLINE CARBON IN ASH ANALYSER SYSTEM
-------------------------	---

Plant No.

- | | | |
|-------|---|--------|
| (i) | Make/Model/Version | |
| (ii) | Client Name & Address | |
| (iii) | Name of Industry (Power plant) | |
| (iv) | Number of measurement system | |
| (v) | Whether above offered system has at-least Two (2) years satisfactory operation as on date of techno-commercial bid opening in min 1 (one) nos. coal-fired boiler of size 500 MW or above where the firing arrangement is similar to the offered boiler. | yes/no |
| (vi) | Client's certificate Attached | yes/no |

Date : (Signature).....

Place : (Printed Name).....

(Designation).....

(Common seal).....

Signature of authorized signatory.....

ANNEXURE II

Quality Plan Format

		BHARAT HEAVY ELECTRICALS LIMITED TIRUCHIRAPPALLI-620014		QUALITY PLAN FOR ITEM NAME				QP number Rev: 00				Page:	
S.No	Component & Operation	Characteristics	Class	Type of Check	Quantum of check		Ref Doc. &	Format of Record	Agency			Remarks	
					M	B/C			M	B	C		
NOTES: 1.LEGENDS: VISU : Visual MECH : Mechanical ELEC : Electrical MEAS : Measurement LGB : Log Book M : Manufacturer					IR : Inspection Report TR : Test Report FAT : Factory Acceptance Test IFAT : Integrated Factory Acceptance Test B : BHEL C : Customer								

ANNEXURE III

Power & Instrumentation Cable Specification

CHAPTER – 16

LV CABLES

1.00.00 CODES AND STANDARD

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 : 3961	Recommended current ratings for cables
IS : 3975	Low carbon galvanised 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:7098 (Part -I)	Cross linked polyethylene insulated PVC sheathed cables for working voltages up to and including 1100V.
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-60754 (Part-I)	Test on gases evolved during combustion of electric cables.
IEEE-383	Standard for type test of Class IE Electric Cables.
IEC -60332	Tests on Electric cables under fire conditions.



	Part-3 : Tests on bunched wires or cables (category -B)
SS-4241475 classF3	Swedish Chimney test
NES-715-1	Temperature index

2.00.00 TECHNICAL REQUIREMENTS

- 2.01.01 The cables shall be suitable for laying on racks, in ducts, trenches, conduits and under ground buried installation with chances of flooding by water.
- 2.01.02 Cables shall be flame retardant, low smoke (FRLS) type designed to withstand all mechanical, electrical and thermal stresses develop under steady state and transient operating conditions as specified elsewhere in this specification.
- 2.01.03 Aluminium conductor used in power cables shall have tensile strength of more than 100 N/ sq.mm. Conductors shall be multi stranded.
- 2.01.04 XLPE insulation shall be suitable for a continuous conductor temperature of 90 deg. C and short circuit conductor temperature of 250°C.
- 2.01.05 The cable cores shall be laid up with fillers between the cores wherever necessary. It shall not stick to insulation and inner sheath. All the cables, other than single core unarmoured cables, shall have distinct extruded PVC inner sheath of black colour as per IS: 5831.
- 2.01.06 For single core armoured cables, armouring shall be of aluminium wires/ formed wires. For multicore armoured cables armouring shall be of galvanised steel as follows : -

Calculated nominal dia of cable under armour	Size and Type of armour
i) Up to 13 mm	1.4mm dia GS wire
ii) Above 13 & upto 25mm	0.8 mm thick GS formed wire / 1.6 mm dia GS wire
iii) Above 25 & upto 40 mm	0.8mm thick GS formed wire / 2.0mm dia GS wire
iv) Above 40 & upto 55mm	1.4 mm thick GS formed wire /2.5mm dia GS wire
v) Above 55 & upto 70 mm	1.4mm thick GS formed wire / 3.15mm dia GS wire
vi) Above 70mm	1.4 mm thick GS formed wire / 4.0 mm dia GS wire



2.01.07 The aluminium used for armouring shall be of H4 grade as per IS:8130 with maximum resistivity of 0.028264 ohm mm² per meter at 20 deg C. Aluminium armouring shall be same as indicated above for galvanized steel.

2.01.08 The gap between armour wires / formed wires 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 of G.S.wire/ formed wire

2.01.09 Cable Identification

1. Outer sheath shall be of PVC (of suitable grade) & black in colour. 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. 21 (As per NES-715-1)
- (b.) Acid gas emission of max. 20% (As per IEC-60754-I).
- (c.) Smoke density rating shall not be more than 60% during Smoke Density Test as per ASTM D-2843.

2. Cores of the cables shall be identified by colouring of insulation. Following colour scheme shall be adopted:

- 1 core - Red, Black, Yellow or Blue
- 2 core - Red & Black
- 3 core - Red, Yellow & Blue
- 4 core - Red, Yellow, Blue and Black

3. For reduced neutral conductors the core shall be black.

4. 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 shall be progressive, automatic, in line and marking shall be legible and indelible.

5. Cores of the cables of upto 5 cores shall be identified by colouring of insulation. Following colour scheme shall be adopted.

1 core - Red, Black, Yellow, Blue

2 core - Red & Black

3 core - Red, Yellow & Blue

2.01.10 All cables shall meet the fire resistance requirement of IEEE - 383 with cable installations made in accordance with clause "Flammability test" and as per Category-B of IEC 60332 Part -3.

2.01.11 Allowable tolerances on the overall diameter of the cables shall be ± 2 mm maximum over the declared value in the technical data sheets.

2.01.12 In plant repairs to the cables shall not be accepted. Pimples, fish eye, blow holes etc, are not acceptable.

3.00.00 Cable selection & sizing

3.01.00 Cables shall be sized based on the following considerations:

- i. Rated current of equipment.
- ii. Maximum voltage drop limits under steady state and during starting for motor being fed from 415V switchgear restricted to 5% and 15% respectively.

Maximum voltage drop limits under steady state and during starting for motor being fed from 415V MCC restricted to 3% and 15% respectively.



Maximum voltage drop limits under steady state for feeder (i.e. Outgoing feeders being fed from 415V switchgear) restricted to 3%.

- iii. For cables to motors and feeders protected by MCCBs the cross section will be chosen according to the tripping time of MCCBs.

3.02.00 Derating Factors

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

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

3.03.00 Cable lengths shall be considered in such ways that straight through cable joints are avoided.

3.04.00 Cables shall be armoured type if laid in switchyard area, coal handling area or directly buried.

3.05.00 All LV power cables except trailing cables shall be XLPE insulated FRLS.

3.06.00 All control cables shall be 2.5 Sq mm copper cable.

3.07.00 Multicore control cables will generally have spare conductor (s) in accordance with the following chart and cores of a single cable will not be split for different auxiliary/equipment:

Conductors	required Cables
1 or 2	1-3/C
3 or 4	1-5/C
5 or 6	1-7/C
7 or 8	1-10/C
9 or 10	1-12/C
11 or 12	1-16/C
13 or 14	1-18/C
Above 14 core	Two or more of above cables



4.00.00 CONSTRUCTIONAL FEATURES**04.01.00 1.1 KV Grade Power Cables**

- (d.) 1.1 KV grade XLPE power cables shall have compacted aluminium conductor for cables including 10 sq. mm and above and copper conductor for cables below 10 sq.mm, XLPE insulated, PVC inner-sheathed (as applicable), armoured, FRLS PVC outer-sheathed conforming to IS: 7098. (Part-I).
- (e.) 1.1 KV grade Trailing cables shall have tinned copper (class 5) conductor, insulated with heat resistant elastomeric compound based on Ethylene Propylene Rubber (EPR) suitable for withstanding 90°C continuous conductor temperature and 250 deg C during short circuit, inner-sheathed with heat resistant elastomeric compound, nylon cord reinforced, outer-sheathed with heat resistant, oil resistant and flame retardant heavy duty elastomeric compound conforming to IS 9968

4.02.00 1.1 kV Grade Copper Conductor Fire Survival Power Cables

- 4.02.01 1100 volt grade, 90 Deg.C rating, Power cables with stranded Copper conductor, heat resistance elastomeric insulation generally conforming to Type IE-2 of IS: 6380-1984, extruded Halogen free or very low Halogen elastomeric inner sheath, generally conforming to Type SE-3 of IS-6380-1984, round wire/strip armour and extruded outer sheath of elastomeric material generally conforming to Type SE-3 of IS: 6380-1984.
- 4.02.02 The cables shall be generally manufactured in conformity to IS-9968 Part-1/1988.
- 4.02.03 The cables shall be rated for 3 hours fire rating.
- 4.02.04 Conductor shall be of stranded construction, consisting of high conductivity annealed plain copper wires conforming to Class-II of IS 8130.
A suitable heat barrier tape, preferably glass mica tape shall be provided over the conductor.
- 4.02.05 The insulation shall consist of heat resisting elastomeric material EPR (Ethylene Propylene rubber) and shall conform to Type IE-2 of IS:6380/1984 amended up to date.



4.02.06 The suitable fire retardant material fillers shall be used for filling in the interstices. Two layers of plain glass fiber binder tape shall be applied over the laid up cores.

4.02.07 Fire Survival Power & Control cables shall be provided for the following services:

- (a.) DC emergency lube oil pump.
- (b.) Turbine lube oil pump/barring gear.
- (c.) Jacking oil pump.
- (d.) Scanner air fan.
- (e.) Incoming & outgoing cables for DC lighting distribution board.
- (f.) Fire /smoke detection system.
- (g.) DC seal oil pump.
- (h.) DC emergency lighting cables for Main Plant Building.
- (i.) Batteries to charger and DC distribution board.
- (j.) Emergency turbine trip by push button in control room.
- (k.) Boiler turbine: Generator inter-trip which includes the interconnecting cables between
 - 1. Boiler master fuel trip and turbine trip relays
 - 2. Generator trip relays and turbine trip relays
 - 3. Generator trip relays and 400 kV circuit breaker
 - 4. Generator trip relays and generator field breaker.
 - 5. Generator trip relays and UAT breaker.

4.03.00 1.1 KV Grade Control Cable

Control cable shall be multi core, minimum 2.5 sq.mm cross section, stranded copper conductor, PVC insulated, inner PVC sheathed / galvanized steel wire armored and outer sheath made of FRLS PVC compound. In situation where accuracy of measurement or voltage drop in control circuit, warrant, higher cross sections as required shall be used. 4 sq.mm copper conductors shall be used for CT circuits, all other specification remaining same. In 4 sq.mm conductor impose unacceptable high burden on CTs, higher cross section of conductor shall be used.

Voltage Transformer leads shall be checked for voltage drop, which shall be limited to within 1 % for all cases other than tariff metering, for which the voltage drop shall be limited to 0.2 %. In case the voltage drop with 4 sq.mm Cu conductors exceeds this value, higher conductor sizes shall be used.



4.04.00 1.1 kV Copper Conductor Fire Survival Control Cables

4.04.01 Conductor shall be of stranded construction, consisting of high conductivity annealed tinned copper conductors conforming to IS 8130/1984 amended up to date.

4.04.02 A suitable heat barrier tape, preferably glass mica tape shall be provided over the conductor.

4.04.03 The conductor insulation shall consist of heat resisting elastomeric material EPR (Ethylene Propylene rubber) and shall conform to Type IE-2 of IS:6380/1984 amended up to date.

4.04.04 An inner sheath of extruded special low smoke and very low halogen content (acid gas generation shall be less than 2% by weight) elastomeric (HOFR) compound of black colour or any other natural colour with prior approval from Owner conforming to Type SE-3 of IS-6380/1984, amended up to date, shall be provided over the laid up cores.

4.04.05 The armouring over inner sheath shall consist of single layer of wire/round galvanized steel wire as per IS 3975 amended up to date.

4.04.06 The outer sheath shall be of special low smoke and very low Halogen content (Acid gas generation shall be less than 2% by weight) elastomeric HOFR compound comprising of synthetic rubber and shall generally conform to the type SE-3 of IS: 6380 latest revision.

4.04.07 The colour of outer sheath shall be black or any other natural colour agreed mutually between Owner and Contractor.

4.04.08 The minimum sizes of L.T. cable to be chosen are as below:
AL-16 mm² (3 core) & Cu – 2.5 mm² (3 core)

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.



4.05.00 Cable Drums

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.

5.00.00 TESTS**5.01.00 Type Tests:**

5.01.01 The reports for the following type tests shall be submitted on one size each of LV Power cables :

S.No.	Type Tests	Remarks
a)	For Conductor	
1.	Annealing test	For copper conductor only.
2.	Tensile test	For aluminium conductor only.
3.	Wrapping test	For aluminium conductor only.
4.	Resistance test	
b)	For Armour Wires/ Formed Wires	
1.	Measurement of Dimensions	
2.	Tensile Test	
3.	Elongation test	
4.	Torsion test	For round wires only
5.	Winding test	For Formed wires only
6.	Resistance test	
7(a)	Zinc Coating test	For G.S. Formed wires /wires only.



7(b)	Wrapping test	For Al. Formed wires /wires
c)	For XLPE insulation & PVC Sheath	
1.	Test for thickness	
2.	Tensile strength & elongation tests before ageing and after ageing	
3.	Ageing in air oven	
4.	Loss of mass test	For PVC sheath only
5.	Hot deformation test	For PVC sheath only
6.	Heat shock test	For PVC sheath only
7.	Shrinkage test	
8.	Thermal stability test	For PVC sheath only
9.	Hot set test	For XLPE insulation only
10.	Water absorption test	For XLPE insulation only
11.	Oxygen index test	For outer sheath only
12.	Smoke density test	For outer sheath only
13.	Acid gas generation test	For outer sheath only
d)	For completed cables	
1.	Insulation resistance test (Volume resistivity method)	
2.	High voltage test	
3.	Flammability test as per clause "Flammability test"	
4.	Flammability test as per IEC - 332 Part-3 (Category -B)	



5.01.02 Flammability Test

- (f.) This test shall generally be carried out as per IEEE 383. The cable installation to be tested shall consist of as many cables as are necessary to give atleast 10 kg of organic material per metre run.
- (g.) The following cable installation shall be tested :
- (1.) Installation with single / multi core cables in touching formation.
- (h.) Size of cables, number of cables, number of layers and laying arrangements for each installation shall be subject to Owner's approval.
- (i.) The size of the cables selected (measured by total cross sectional area of the conductor) shall have maximum organic material per sq. mm of total cross sectional area of all the conductors.

5.01.03 Acceptance Tests

Acceptance tests shall be carried out on each type and size of the cables on the cable drums selected at random as per following sampling plan:

S. No.	No. of drums in the lot	No. of drums to be taken as sample
1.	Upto 100	10% (Subject to minimum of 1 drum)
2.	101 to 300	13
3.	301 to 500	20
4.	Above 500	32

The following shall constitute acceptance tests :

- Item No. 1 to 14, 16, 19, 20, 22, 23, 24, 25 of list of type tests specified in 9.03.01 of chapter 15.
- Fire resistance test as per SS 4241475 (F3 category)
- One length per size / lot for surface finish and length measurement
- Lay length / sequence of cores, armour coverage, Gap between two consecutive armour wires / formed wires, Band marking.

5.01.04 Routine Tests

Routine tests shall be carried out as per relevant standard for each drum of cables of all types and sizes.



9.06.00 INSTRUMENTATION AND CONTROL CABLES**9.06.01 General**

Bidder's scope of supply, laying, erection & commissioning of instrumentation and control cables shall include the following:-

- a) Bidder shall supply, lay, erect, *terminate* all type of cables required for power plants i.e. the control, instrumentation, *interfacing (coaxial, fibre optic) cables etc.* irrespective of other end scope.
- b) All interconnecting cables and prefabs between bidder's supplied instruments, local JB, local instrument/transmitters, cabinets, panels and termination cabinets and interconnecting cables between Bidder's panels to equipment / instruments/ Plant Control Room. All field JB's / all field instruments/MCC/SWGR to DDCMIS/DCS cabinets in CER/ PLC cabinets/Relay cabinets/local control panels/desk etc. All power, Signal & Special cables from Sensor to JB, JB to MCC, JB/Drives to PLC/DDCMIS/DCS, MCC/SWGR to DDCMIS/DCS/PLC cabinets wherever one end or two ends are in EPC bidder's scope. Complete Cables shall be supplied, laid, terminated & commissioned by EPC bidder including preparation of Cable schedule and supply of cable Trays irrespective of other end scope.
- c) All co-axial cables/*fibre optic cables* and any other special cables for *interfacing with other packages via soft link (covering all packages irrespective of scope).*
- d) K Type Thermocouples Extension cables, T Type thermocouple Extension cables and S/R type Thermocouple Compensating cables
- e) Interfacing cables (*Coaxial, fibre optic etc*) between owner supplied PLC/control systems (if any) to DDCMIS.
- f) Fire survival cable
- g) Preparation of Complete cable schedule, Interconnection diagram & JB schedules shall be in bidder scope.
- h) All others cables not included above however required for completeness and operation of plant.
- i) The cables shall be provided in non returnable wooden drums. The drum length shall be 1000 m $\pm$ 5% up to & including 12 pair cables and 500 m $\pm$ 5 % for above 12 paired cables.

The quantity of the above types of cables shall be estimated by the Bidder based on his experience.

Any shortfall in cable quantity during actual laying at site shall be compensated by the Bidder at no extra cost to the owner.



Bidder shall supply the specified type of cable on as required basis for different cabling and interconnection work, provided the same meet the requirements of Bidder's I&C application.

9.06.02 **SPECIFICATION AND STANDARDS**

9.06.02.01 Except where specified otherwise all materials , cables and construction shall conform to the Indian Electricity Act and Rules and the Indian and other international standards with latest revisions and amendments issued up to date.

9.06.03 **MATERIAL SPECIFICATIONS**

9.06.03.01 **General**

9.06.03.02 All materials shall be new and of tested quality conforming to applicable National and Manufacturer's Standards and Indian Electricity Rules.

9.06.03.03 All materials shall be transportable to and suitable for installation at site with ease and without any damage. It shall give continuous reliable operation over long period under worst specified site conditions.

9.06.03.04 All materials shall be designed to withstand extremes of all magnetic, electrical, mechanical and thermal stresses which may be encountered during normal and abnormal operating conditions.

9.06.04 **Cables – Design Criteria**

9.06.04.01 Cables shall be so designed and manufactured that damage does not occur in handling, during transit, storage, installation and operation under any or all the climatic and operating conditions which they may be subjected to. Outer sheath of cables shall have rodent and termite repulsion property.

Cables shall be suitable for laying in conduits, ducts, trenches, trays or for direct burial in ground in both and wet locations.

9.06.04.02 Cables shall be capable of operating satisfactorily under the power supply voltage and frequency variations as specified in the specification. Current ratings and ratings factors of cables shall not be worse than the ones specified in IS: 3961.

9.06.04.03 Performance characteristics of cables shall be based on the following conditions of laying:

1. All cables shall be laid in multilayer and touching each other.
2. Cables shall be suitable for laying in duct or burying in ground upto a depth of 1.5 meters with uncontrolled back fill and chances of flooding by water.

9.06.04.04 Fillers in multiple conductor cables shall be flame retardant and moisture resistant.



- 9.06.04.05 All cables shall be provided with marking including manufacturer's name, insulation material, conductor sizes, no of pairs, voltage ratings, type of cable, etc, progressive markings to read marking of the length of the cable at each meter interval and "FRLS".
- 9.06.04.06 All cables shall be suitable for continuous operation at 85 deg C except for high temperature resistant Teflon insulated cables, which shall be suitable for continuous operation at 205 deg C.
- 9.06.04.07 All the cables used in the Hot/high temp. Zone (Combustor region), for emergency trip push buttons, Fire alarm system, safety critical circuits, Trip protection circuits and for other services specified elsewhere in the specification shall be fire survival cable conforming to IEC 60331, BS6387 (CWZ), BS6207 standard and this specification. The instrumentation cables in other area shall be FRLS conforming to IEC 60332 standards and this specification.
- 9.06.04.08 All external field signals for DDCMIS/DCS/PLC shall be terminated in separate marshalling/termination cabinets. Under no circumstances, Field cabling to be directly terminated in DDCMIS/DCS/PLC system cabinets.
- 9.06.04.09 All cables shall be paired cables.
- 9.06.04.10 All cables shall be provided with anti termite, Anti Rodent & moisture resistant properties.
- 9.06.04.11 All spare contacts/terminals on relays, control switches, limit switches or similar devices, process switches, duplex RTDs & Duplex T/Cs shall be wired to accessible terminal blocks/JBs for Owner's future connections. All wiring leaving a junction box or enclosure shall leave from terminal blocks and not from other devices in the enclosure. Two (2) pair (individual & overall shielded) cables shall be provided for terminating the thermocouples, transmitters & switches i.e Analog & Binary signals to local JB's. Similarly four (4) pair (individual & overall shielded) cables shall be provided for terminating the Duplex (3/4 wire) RTD to local JB's.
- 10% spare pairs or min 1 pair cable (which ever is more) shall be provided with all type of cables.
- 9.06.03.12 Cable size & type shall be as below for different type of signals and control system.
- Cables for analog signals shall be instrumentation cable of 0.5 sq. mm copper conductor size, with individual pair shielding & over all shielding as per cl. No. **9.06.04.02** mentioned below.
 - Cables for binary signals shall be instrumentation cable of 0.5 sq. mm copper conductor size as per cl. No. **9.06.04.02** mentioned below with exceptance of over all shielding only.
 - Cables for binary signals in relay based system and Fire protection & detection system shall be instrumentation cable of 1.5 Sq.mm conductor size, overall shielded as per cl. No. **9.06.04.01** mentioned below.



- d) Cable for power supply to each solenoid valves shall be control cable of 3C x 2.5 Sq.mm copper conductor size. Specification shall be as mentioned elsewherein the Electrical part.
- e) For cables single length more than 500 meters, the size of conductor shall be 1.5 sq. mm only irrespective of type of signals.

9.06.05 Cable Specification

9.06.05.1 The Instrumentation cables shall function without breakdown for surges experienced in the control system. Voltage class and insulation levels shall be compatible with the signals they convey.

9.06.05.2 Cable Specifications

Cable shall have the following specification: -

<u>Sr.No.</u>	<u>Description</u>	<u>Cable N</u>
1.	Voltage Grade and Type	660 V/1100 V grade multipair annealed tinned copper conductor overall shielded armoured instrumentation cable.
2.	IS Reference	IS: 1554 (Part-I Generally)
3.	Conductor	Nominal 1.5 Sq. Area concentric lay Annealed tinned high conductivity Stranded 7x0.53 mm dia. Electrolytic Copper conductor.
4.	Insulation	Extruded HR PVC type – C to IS:5831
5.	Shield	Minimum 0.06mm thick aluminum mylar tape shall be provided on each pair with hundred percent coverage, 25% overlap and tinned copper drain wire of diameter 0.8mm with 7 strands.
6.	Inner sheath	FRLS HR PVC type ST-2 to IS:5831/VDE 0207. Colour Black.
7.	Armouring	Galvanized steel wire/strip to IS:3975 & IS 1554 Part II
8.	Outer sheath	FRLS HR PVC type ST-2 to IS:5831/VDE 0207. Colour Blue.
9.	Lay	Twisted pair with 25 - 40lay/mt
10.	Tests for FRLS Properties	1. <u>Flammability Test</u> The cables shall pass The requirement of IEEE-332 part B fire propagation test in this regard.



2. Smoke generation by Sheath under fire
When tested as per ASTM-2843, the cable shall meet the requirement (60%) smoke density.
3. Acid gas generation of sheath during fire
When tested as per IEC-754-1, the maximum Acid gas should be less Than 20% by weight.
4. Oxygen Index Test
The oxygen index when tested under ASTM D 2863 shall be minimum 29.
5. Water immersion test shall be carried out as per VDE 0815
6. Swedish Chimney Test

Other Tests:

1. Fire resistance test to IS-5831 for 20 minutes. (PVC insulation & sheath of electrical cables)
2. Thermal stability at 200 deg. C to IEC-540 for 100mts.
3. Rodent and termite proof.
4. Heat shock test to IEC-502.

11. Conductor and Pair : The wires of pairs shall be coded by base colours on insulation which are repeated in every unit. Base colours of the pairs in a unit shall be as follows:

Pair	1	2	3	4
------	---	---	---	---

- | | | | | | |
|----|------|------|--------|-------|-------|
| a) | wire | Blue | Grey | Green | White |
| b) | wire | Red | Yellow | Brown | Black |

The units shall be coded by colours of rings on the insulation cores as tabulated below in order to distinguish between wires of various units in cables :

Unit: Ring Colour: Ring Group



1.	PINK	I
2.	PINK	II
3.	PINK	III
4.	PINK	IIII
5.	PINK	IIIII
6.	ORANGE	IIIIII
7.	ORANGE	IIIIIII
8.	ORANGE	IIIIIIII

The vertical lines under column (Ring Group) in the above table indicate number of rings at intervals of approx 60 mm length of the wires of the units. For cables above 4 pair, each 4 pair units shall be open helically lapped with numbered binder taped for the purpose of binding & unit identification.

12. Marking Marking on length of the cable shall be at every meter interval on the outermost PVC sheath of cables.

13. **Electrical Properties at 20 Deg.C:**

a)	Conductor resistance of the loop not greater than	78.4 Ohms/Km for 0.5 sq mm. Conductor size.
		24.6 Ohms/Km for 1.5 sq mm. Conductor size.
b)	Insulation resistance not less than	100 Meg Ohms/Km
c)	Mutual capacitance at 0.8 KHz not greater than	100 nF/Km
d)	Test Voltage-cond/cond. and cond/shield	2000 Vrms
e)	Characteristic impedance at 0.8 KHz	370 Ohms for 0.5 sq mm. Conductor size.
		230 Ohms for 1.5 sq mm. Conductor size.
f)	Image attenuation at 0.8 KHz	0.11 dB/100 m
g)	Image attenuation at 10 KHz	0.29 dB/100 m
h)	Cross talk attenuation at 0.8 KHz greater than	70 dB/Km
i)	Coupling capacitance at 0.8 KHz not greater than	200 pF/100 m
j)	Min Vol. Resistivity	: 3.5×10^{14} at 27 deg C



3.5 x 10¹¹ at 85 deg C

k)	High Voltage Test	:	Duration
	Conductor to Conductor	:	2000 Vrms, 50 Hz for 1 min.
	Conductor to Shield	:	2000 Vrms, 50 Hz for 1 min.

9.06.05.3 Cable Specifications

Cables shall have the following specifications:-

<u>Sr.No.</u>	<u>Description</u>	<u>Cable – M</u>
1.	Voltage Grade and Type	660V/1100 V grade multipair annealed tinned copper conductor individual pair and overall shielded armoured instrumentation cable.
2.	IS Reference	IS:1554 (Part-I) (Generally)
3.	Conductor	Nominal 0.5 Sq.mm. area concentric lay annealed tinned high conductivity stranded 7 x 0.307 mm dia. Electrolytic Copper conductor
4.	Conductor size	: Overall dia of each conductor including insulation should be between 1.4 to 1.65 mm. For 0.5 sq mm. size conductor.
5.	Insulation	Extruded HR PVC type-C to IS:5831
6.	Shield	Through aluminum mylar tape min 0.06 mm (0.075 mm) with min 25% overlap and 0.8 mm dia tin coated copper drain wire (7 stranded) laid under the contact with aluminum side of the tape.
7.	Inner sheath	FRLS HR PVC type ST-2 to IS:5831/VDE 0207, Colour Black
8.	Armouring	Galvanised steel wire/strip to IS:3975
9.	Outer sheath	FRLS HR PVC type ST-2 to IS:5831/VDE 0207, Colour Black
10.	Test for FRLS properties	"See details as specified in Cable Type N".
11.	Colour Coding & Marking	- do-
12.	Electrical Properties	- do-

9.06.05.4 Specification for Co-axial Cables Cable-C

Co-axial cables are used for high frequency equipments and systems for transmission and reception purposes and computers. Co-axial cable should have minimum following characteristics:-



Construction	:	Solid silica coated, annealed tinned copper conductor.
Di-electric	:	Low loss solid polyethylene foam, semi and spaced construction.
Outer conductor	:	Braided or longitudinal tube of copper or Aluminum giving 100% coverage with slight overlap.
Outer sheath	:	FRLS PVC type ST2
Diameter over Di-electric	:	7.24 sq.mm.
Outer diameter	:	10.29 sq.mm.
Nominal impedance	:	75 ohms
Nominal capacitance	:	20.5 pF/ft.
Nominal attenuation	:	8 dB at 1000 MHz Per 100 ft.

Co-axial cable shall be low smoke (ASTM- E 662), flame retarded (IEEE 383) and halogen free (IEC 754: 1 & 2), MIL C-17 G.

9.06.05.5 Extension & Compensating Cables

1. Applicable Standards : ANSI MC96.1; IS:1554 (Part-I) IS:5831-1984
2. Type : Single / Multipair twisted and shielded type as per ANSI MC96.1
3. Conductor Size : 1.31sqmm, solid alloy (16 AWG)
4. Conductor Diameter : 1.29 mm
5. Insulation : PVC insulated, heavy duty, Self extinguishing type. Colour coded extruded PVC inner sheathed with overall PVC sheathed Type ST2 FRLS IS: 5831. Insulation of each wire with high grade 0.6 mm 85 deg.C Extruded HR PVC Type C as per IS: 5831, voltage grading shall be 1.1 kV.
6. Lay : Twisted pairs within 50 mm max. lay.
7. Shield : Single pair cable assembly only. Multiple pair - each pair and cable assembly. Each conductor shall be individually and overall shielded Through aluminum mylar tape min 0.06 mm (0.075 mm) with min 25% overlap & 100% coverage and 7 strand 20 SWG minimum size tin coated copper drain wire.
8. Outer sheath : FRLS HR PVC type ST-2 to IS:5831
9. Conductor Identification : See "Cable Details" as below
10. Armour : Galvanised steel wire/strip to IS:3975
11. Multiple pair identification : Each pair numbered every 250 mm



12. Electrical Parameters:

Thermo electric specification, limit of error shall be as per IEC, ANSI

Description	KX type	SX/RX Type	TX Type
E.M.F at 100 Deg.C	4.095mV	0.646/0.647 mV	4.279 mV
E.M.F at 200 Deg.C	8.137mV	1.441/1.469 mV	9.228 mV
Tolerance	± 2.2 °C from 0°C to 200°C	± 1.5 °C from 0°C to 200°C	± 1.0 °C from 0°C to 100°C
Conductor loop resistance for 1.31 sq. mm (16 AWG) size as per ANSI MC96.1 at 20 Deg.C Ohms/K.Mtr	760 (Typ)	95 (Typ)	390 (Typ)

Insulation Resistance (min) : 100 M ohm x KM
Mutual Capacitance at 0.8 resp. 1 KHz (max):

- Single pair and pair screened : 120nf/KM
- upto 4 pair overall screened : 96 nf/KM
- above 4 pairs overall screened : 80 nf/KM

13. CABLE DETAILS

ANSI Type	Conductor Material		ANSI Colour Code		
	Positive	Negative	Positive	Negative	Overall
KX type Extension cable for K type Thermocouple	(NICR/NIAl) Cromel	(Nicht/NiAl) Alumel	Yellow	Red	Yellow
SX/RX type Compensating cable for type S & R thermocouple	Cu (Copper)	Cu Ni (Copper-Nickel alloy)	Black	Red	Green
TX type Extension cable for type T thermocouple	Cu (Copper)	Constantan	Blue	Red	Blue

14. Tests to be conducted:

- Thermo-e.m.f characteristics
- Continuity test
- Measurement on capacitance, inductance and loop resistance.
- Insulation resistance
- High voltage tests as per IS(latest)
- Tensile and elongation tests
- Flame retardency as per IEC 332
- Oxygen index test



9.06.05.6 Fiber Optic Cable

A	Fiber: The optical fiber core shall be of ultra pure fused silica glass coated with UV-cured acrylate suitable to withdraw temperature of about 80 Deg C (continuous). Fiber Optic cables shall be suitable for installation on cable tray, duct bank, cable trench, direct burial as necessary.		
1	Type	Multiple single mode & Multi-Mode Fiber to avoid usage of any repeaters.	
2	Core Diameter	Multimode Fiber cable	Singlemode Fiber cable
		62.5 ± 2 microns or 50 ± 2 microns depending upon distance between source & destination.	9 ± 1 microns
3	Cladding Diameter	125 ± 2 microns	
4	Fiber Proof test	As per IEC/EIA & other international standard.	
5	Coating Diameter Test	As per IEC/EIA & other international standard.	
6	Number of Fibers/core	Six (Colour Coded) with min. 100% spare core (Fibers)	
B1	Optical Characteritics – Bandwidth, Attenuation & Numerical Aperture	For multimode fiber cable with core diameter 62.5 ± 2 microns:	For multimode fiber cable with core diameter 50 ± 2 microns:
1	Bandwidth @ 850 nm Bandwidth @ 1300 nm	160 MHz-Km min 500 MHz-Km min	500 MHz-Km min 500 MHz-Km min
2	Attenuation @ 850 nm Attenuation@ 1300 nm	3.0 dB/Km max 0.8 dB/Km max	3.0 dB/Km max 0.8 dB/Km max
3	Numerical Aperture	0.275 ± 0.015	0.200 ± 0.015
B2	Optical Characteritics - Attenuation	for Singlemode fiber cable outside plant:	for Singlemode fiber cable inside plant:
1	Attenuation@ 1310 nm Attenuation@ 1550 nm	0.35 dB/Km max 0.2 dB/Km max	1 dB/Km max 1 dB/Km max



C	Cable Construction: Fiber Optic cable shall be of loose tube design. Typically, fibres shall be housed in groups of 6 (minimum) within gel-filled buffer tubes to protect against ingress of moisture and vibration. The tubes shall be manufactured with industry standard material tools & practices. The buffer tubes shall be stranded around the central strength member utilizing reverse oscillating lay (ROL). Blank fillers shall be used as necessary to maintain circular cable structure. Fillers shall be flame retardant and moisture resistant. The cable shall be of dual jacket & armoured. Optic Fibre cable shall be polymer coated, galvanised corrugated steel taped armoured, fully water blocked with central dielectric material for outdoor/indoor application so as to prevent any physical damage. Two highly visible ripcords are placed under the jacket to aid in sheath removal. A co-polymer coated steel tape is corrugated and wrapped around the inner jacket to provide additional cable compression strength and Termite & rodent protection. A ripcord is also placed underneath the armour for easy outer jacket removal.	
1	Outer Colour	Orange
2	Outer Jacket	Polyethylene minimum 1.5mm thick, Flame retardant & UV resistant.
3	Inner Jacket	Core-locked flame retardant polyethylene
4	Filler / Strength member	As per Manufacturer's standard
5	Central Strength member	FiberGlass reinforced plastic (FRP) and Buckle resistant material to provide both tensile and anti bucking strength to the cable.
6.	Details marked at every meter on outer sheath.	Manufacturer's Name, Month and Year of Manufacturer, Coded description of the cable based on telcordia's (bellcore) SR-2014 suggested optical cable code (SOCC), Sheath identification Number, Sequential Length marking in meter, A telephone Handset symbol to distinguish communication from power cable as per NESC section-35G.
7.	Life Expectancy	Fiber Optic cable shall provide a long life expectancy of minimum 25 years under continuous operation without degradation to optical or mechanical performance.
D	Stripping Ability	All layers easily removed with Commercially available tools
E	Installation:	
1	Minimum bending radius	20 X D (D=core Diameter) - During Installation , Short Term , loaded 15 X D (D=core Diameter) – Installed, Long

		Term , No load
2	Maximum Tensile Load/Strength	During Installation: 2200 N Installed: 1500N
3	Method of laying	Directly laid in cable trays / duct bank / clamped with available structure
4	Pulling	Ordinary cable grips
F	Storage Temperature	- 20 ⁰ C to 60 ⁰ C
G	Operating Temperature & Humidity	- 20 ⁰ C to 70 ⁰ C & 100%
H	Data Speed performance	10 Gbps minimum
I	Test Specification (EIA/TIA – STD455 or Equivalent):	
1	Impact Resistance	2000 Impacts minimum
2	Crush Resistance	4000 N/10cm minimum
3.	Compressive Strength	3000 N minimum
J	Moisture/Water Resistance	Water blocking layer, Cable shall withstand water penetration when tested with a one meter static head or equivalent continuous pressure applied at one end of a one meter length of filled cable for one hour. No water shall leak through the open cable end.
K.	Optical time Domain reflectometer	a. A recording optical time domain reflectometer (OTDR) will be utilized to test for end-to-end continuity and attenuation of each optical fiber. The OTDR shall be equipped with data storage, printer, help feature, compare trace features and OTDR software. The data storage unit must include a built-in floppy disk drive capable of storing a minimum of 100 test traces. b. Data traces saved to disk shall include the following labels. i. Fiber Identification (ID) with a minimum of 10 characters. ii. Cable ID with a minimum of 10 characters iii. OTDR location with a minimum of 20 characters iv. Far End location with a minimum of 20



		characters. v. Test operator initials with a minimum of 3 characters. c. The printer shall preferable be internal. The printer shall be able to print data traces within 30 seconds or less. The machine setting used to repeat tests at a later time shall include index, range, wavelength, average time, pulse width and scale settings. The test results (on printout) shall provide information including: loss, distance, reflectance, data and time. d. The requirements for the compare trace feature include the ability to recall two historical traces from a diskette and display them simultaneously for analysis and printing. The compare trace must compute and display a single graph representing any differences between two traces. The compare trace must be able to recall historical traces from a discrete and perform the same tests on connected live fibers. The compare trace shall perform a two point loss measurement test for any two particular fibers in a comparison analysis. The losses between the two points on the each fiber shall be displayed, and the differences between the two readings clearly shown. e. The OTDR must be equipped with software to support all of the required functions. The software shall provide for printing of whole set of traces (batch print) with minimal commands eliminating the time spent for printing traces individually. f. Bidder shall provide all mounting accessories, cables and connectors required to establish data communication.
L.	Fiber Optic splicer, terminator and tool kit box	Bidder shall provide new unused tools comprise of splicer and fusion jointer and tool kit comprise of cutter, stripper,



		polishing tool, handheld microscope, heat shrinkable sleeve, scissor, knife etc as required for maintenance and commission.
M.	Standards	Optical cable shall be conform to i) IEC 60794/IEC 60793 & EIA/TIA 455. ii) Low smoke(IEC 1034 -light transmittance of 80%). iii) Halogen free(IEC 754: 1&2- maximum acid gas generation shall be 2% by weight and PH >4.3). iv) Fire & flame retarded (IEC 331,IEEE 383). v) Rodent resistant. vi) Crush Resistant (EIA -455-41). vii) Impact Resistant (EIA -455-25). Bidder shall submit Type test report for review ,conform to IEC 60794, IEC 60793, IEEE 383, IEC 754: 1 & 2,IEC 331 ,IEEE 1034 and EIA/TIA standard. Colour codes shall be as per EIA/TIA 598-A.
N.	TESTS	Following minimum test as per any approved standard shall be carried out on the cables: a. Attenuation and Dispersion characteristics tests b. Proof Tests c. Macro-Bend resistance Test d. Mechanical Test e. Low and High Temperature cable Bend Test f. Impact resistance Test g. Compressive strength Test h. Tensile strength Test i. Cable Twist test j. Cable cyclic flexing test k. Environmental characteristics Test l. Temperature cycling test m. Colour permanence Test n. Cable Aging test o. Water penetration test p. Lightning Test q. Kink Test r. Crush Test

9.06.05.7 Data Cable:

2 x 660 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



Data transmission cables are control & signal cables used in electronics of computer system, electronic control equipment etc. in power plant data processing system. The cable has an overall screening which suppresses external electrical influences and ensures precise pulse transmission. The screen braiding of tinned copper wires is wrapped around the core or inner sheath.

i) Min. bending radius for flexing	:	15x cable diameter.
ii) Temp. Range	:	(-30 to +80) deg. centigrade
iii) Loop resistance	:	Max.78.4 ohm/km.
iv) Inductance	:	0.65 mH / Km.
v) Coupling	:	200 pF / Km.

Co axial and fibre optic cables are also used as data cables.

9.06.05.8 **NOTE:** All cables near high temperature zone shall be high temp cables, which shall be terminated at a junction box in normal temperature zone. Thermocouple extension cables and copper conductor cables for high temperature applications shall be with insulation of individual conductor and outer sheath of extruded FEP (i.e. Teflon) as per VDE 0207 Part 6 and ASTM D 2116. The thickness of insulation shall be 0.5 mm nominal (i.e. 0.4 mm minimum). These cables shall be single / Multipair twisted & shielded.

9.06.05.9 Fire survival instrumentation Cables shall be similar to the Fire survival control cables specified in electrical section (Vol. IV) except that Cables for analog signals shall be annealed tinned copper conductor 0.5 sq. mm sized, with individual pair shielding & over all shielding and Cables for binary signals shall be annealed tinned copper conductor 0.5 sq. mm sized with over all shielding only. In addition the cables shall have high degree of immunity from electromagnetic interference.

9.06.06 **TYPE AND ACCEPTANCE TESTS FOR INSTRUMENTATION CABLES**

9.06.06.01 After completion of manufacture, type and acceptance tests as specified in relevant standards and herein shall be conducted and requisite number of copies of test certificates as per Distribution Schedule shall be furnished.

9.06.06.02 The Owner may, at his discretion, waive type tests provided type tests reports of tests carried out on identical materials(s) manufactured by the Bidder in India in last 5 years are furnished. The Bidder shall furnish copies of such type test reports with the Bid or indicate when they expect to make these available.
After completion of manufacture, following minimum type and acceptance tests as specified in relevant standards and herein shall be conducted and requisite number of copies of test certificates shall be furnished. The Owner may, at his discretion, waive type tests provided type tests reports of tests carried out on identical materials(s) manufactured by the Bidder in India are furnished. The Bidder shall furnish copies of such type test reports with the Bid or indicate when they expect to make these available.

I. TYPE TESTS:



The type tests shall be carried out on one drum out of every 10 drums or less for each size of cable in each lot, in presence of Owner's representative as per applicable standards in Govt. approved Laboratory if adequate testing facility is not available at works of the supplier.

Sr. No.	Name of Test	Governing standard	Special requirements as per owner's specification.
1.	Annealing test (for copper)	IS : 8130/84	As per IS: 8130/84
2.	Conductor resistance test & Diameter test	IS : 10810	As per approved G.T.P.
3.	Per sulphate test (for tinned copper wire)	IS : 8130/84	As per IS: 8130/84
4.	Test for armours wires / strips	IS : 3975	As per IS:3975
5.	Test for measurement of DC resistance of armour	IS: 1554 (I)	As per approved G.T.P.
6.	Test for measurement of thickness of insulation & sheath & other dimensions.	IS : 1554 (I)	As per approved G.T.P.
7.	Measurement of volume resistivity of HRPVC insulation	IS : 5831-1984	i. 3.5×10^{14} Ohm-cm at 27°C / room temp.(Min). ii. 3.5×10^{11} Ohm-cm at 85°C (Min.)
8.	Tensile strength and elongation test for insulation & sheath.	IS:5831/1984	As per IS:5831/84
9.	Ageing test for insulation & sheath. Loss of mass test for PVC insulation & sheath.	IS:5831/1984	As per IS:5831/84
10.	Shrinkage test for PVC insulation & sheath.	IS:5831/1984	As per IS:5831/84
11.	Shrinkage test for PVC insulation & sheath	IS:5831/84	As per IS:5831/84
12.	Hot deformation test for PVC insulation & sheath	IS:5831/1984	As per IS:5831/84
13.	Cold bend test for PVC insulation.	IS:5831/1984	As per IS:5831/84
14.	Cold impact test for PVC sheath.	IS:5831/1984	As per IS:5831/84
15.	Heat shock test for PVC insulation & sheath.	IS:5831/1984	As per IS:5831/84
16.	Thermal stability test for PVC insulation and sheath.	IS:5831/1984	As per IS:5831/84



17.	Test for bleeding and blooming of pigments for PVC insulation of sheath.	IS:5831/1984	As per IS:5831/84
18.	Colour fastness to water.	IS:5831/1984	As per IS:5831/84
19.	Colour fastness to day light.	IS:5831/1984	As per IS:5831/84
20.	High voltage test (water immersion test)	IS:1554(I)	IS:1554(I)
21.	Test for rodent & termite repulsion property of sheath.	-	Presence of lead shall be detected.
22.	Oxygen index test on inner & outer sheath material.	ASTM:D-2863/77	Min.29
23.	Temp. index test on inner & outer sheath material	ASTM:D-2863/77	Min.250°C
24.	Acid gas emission test on inner & outer sheath material.	IEC-754-1	Acid gas generation shall be less than 20% by weight.
25.	Smoke Density test on inner & outer sheath material	ASTM-D-2843/77	Min. 40% light transmission during test.
26.	Flammability test on finished cable samples as per following methods: i. Swedish chimney test ii Vertical tray flame propagation test. iii. Single vertical cable fire resistance test.	SS-424-14-75 Cl. F-3 IEEE-383 IEC-332-1	SS-424-14-75 Cl. F-3 IEEE-383 IEC-332-1
27.	Tests for all electrical properties at 20°C & maximum operating temp. as per GTP.	As per GTP	As per approved G.T.P.
28.	Oxygen index test & Acid Gas generation test for Fillers	ASTMD – 2863, IEC 60754-1	As per approved GTP
29.	Continuity test, Shield thickness, Overlap test of Al Mylar shield	As per GTP	As per approved GTP
30.	Noise interference test, Cross talk test, Mutual capacitance, Drain wire continuity test.	IEEE Transaction, VDE 0472	As per approved GTP

II Routine Test:

Routine test shall be carried in presence of owner's representative for all types of cables.



- | | | | |
|----|------------------------------|-------------|------------------------------|
| 1. | High voltage test | IS:1554 (I) | 2 KV (RMS)
for one minute |
| 2. | Conductor Resistance
Test | IS:8130/84 | As per GTP |

III Acceptance Tests:

Following tests shall be carried out on 1 drum out of every 10 drums or less for each size of cables in each lot, in presence of owner's representative.

- | | | | |
|----|--|--------------|---|
| 1. | High voltage test | IS:1554 (I) | 2 KV (RMS)
for one minute |
| 2. | Conductor Resistance
Test | IS:8130/84 | As per NIT |
| 3. | Volume Resistivity | IS:5831-1984 | (i) 3.5×10^{14} -cm
at 27 deg C/room
temp (Min)
(ii) 3.5×10^{11} ohm-cm
at 850C Min.
100 NF/Km (max) |
| 4. | Measurement of Mutual
capacitance at 0.8 KHZ | | |
| 5. | Calculation & Verification of
Characteristic impedance on
the basis of value obtain for
mutual capacitance at 0.8 KHZ
with the help of following formula | | |

$$Z = \frac{R}{2fc} \quad 320 \text{ Ohms(nominal)}$$

where Z = characteristic impedance in ohm

R = Loop resistance of cable per km in ohms at 20 °C
f = Frequency of test in Hz (800)
c = mutual capacitance per km.

- | | | | |
|-----|--|--------------------|------------|
| 6. | Measurement of thickness
of insulation and sheath &
other dimensions | IS:1554 (I) | As per NIT |
| 7. | Tensile strength and
elongation at break
of insulation & sheath | IS:5831/84 | IS:5831/84 |
| 8. | Oxygen index test on
inner & outer sheath
at room temp. | ASTM-D-2863 Min.29 | |
| *9. | Temp. index test on
inner & outer sheath | --do-- | Min.250°C |



*10.	Acid gas emission test on inner sheath & outer sheath.	TEC-754-1	Max.20% by weight
11.	Smoke density test on inner sheath & outer sheath	ASTM-D-2843	Min.40% light transmission during test.
12.	Flammability test	SS-424-14-75 Class F-3	SS-424-14-75 Class F-3
13.	Additional Test	IEC 331	for fire survival characteristics

* (If no. of drums selected for acceptance test for a particular cable size are more than one, the tests marked with * i.e. 5 no. 9&10 under acceptance tests shall be carried out on one drum only).

9.07.00 SHOP TESTS FOR ERECTION HARDWARE

i) General Requirements:-

- a) The equipment as per this section shall be subject to shop tests.
- b) The Conductor shall furnish all materials, equipment, tools, instruments, bulkheads, blanking plates and all personnel required for completing these tests.
- c) Personnel performing the tests shall be qualified and experienced. Tests shall be performed as many times as necessary to assure Proper quality of materials and workmanship. If any test reveals Unsatisfactory materials or workmanship, such materials shall be Repaired or replaced to the satisfaction of the Owner.
- d) Hydrostatic and pneumatic tests shall be performed on all pipes, Tubings and systems supplied by the Bidder and shall conform To ANSI B31.1 – Code for Pressure Piping.

ii) Hydrostatic Testing

All instrument piping, which connects to process piping, shall be Hydrostatically tested.





429-024

PURCHASE / MM / FB
SUB DELIVERY - ENQUIRY - DEVIATION

Page

OF

SCHEDULE OF DEVIATION TO
SUB - DELIVERY ENQUIRY No.

DATE

DESCRIPTION			
SPECIFICATION		DRG. No.	
QUALITY PLAN			
DOCUMENT REFERENCE	BHEL ENQ. CALLED FOR	FIRM'S ALTERNATE OFFER	

CERTIFIED THAT OTHER THAN THE ABOVE DEVIATIONS, WE ARE ACCEPTING ALL THE OTHER SPECIFICATIONS AND REQUIREMENTS IN FULL TO YOUR ENQUIRY

STATION :

DATE :

SIGNATURE OF FIRM'S REPRESENTATIVE

FIRM SEAL

- NOTE: 1. Deviations should be taken only in the extreme case.
2. If necessary, use additional sheets with page control number.

Details of Gateway Airport with applicable Foreign Currency and Airlines for FSC payment **Schedule F**

Sch. No.	Country	CUR Code	Gateway Airport/s	Airlines with its Code For FSC Payment will be made	
D01	UK	GBP	London (Heathrow)	Air India	AI
D02	UK	GBP	New Castle	British Airways	BA
D03	UK	GBP	Oxford, Chellam	British Airways	BA
D04	UK	GBP	Bristol, Wellingborough	British Airways	BA
D05	UK	GBP	Birmingham	British Airways	BA
D06	UK	GBP	East Midlands	British Airways	BA
D07	UK	GBP	Manchester	British Airways	BA
D08	UK	GBP	Leeds	British Airways	BA
D09	UK	GBP	Glasgow	British Airways	BA
D10	France	EURO	Paris (Roissy) & Lyon	Air India	AI
D11	Sweden	EURO	Stockholm	Emirates	EK
D12	Sweden	EURO	Gothenberg & Malmo	Emirates	EK
D13	Italy	EURO	Rome, Milan	Carrier Used	Carrier Used
D14	Italy	EURO	Turin, Bologna, Florence	Carrier Used	Carrier Used
D15	Netherlands	EURO	Amsterdam, Rotterdam	Klm Airlines	KLM
D16	Austria	EURO	Vienna, Linz, Graz	Lufthansa	LH
D17	Belgium	EURO	Antwerp, Brussels	Singapore Airlines	SO
D18	Denmark	DKK	Copenhagen	Cathay Pacific	CX
D19	Japan	JPY	Tokyo, Osaka	Air India	AI
D20	Singapore	SGD	Singapore	Air India	AI
D21	Canada	CAD	Toronto	Carrier Used	Carrier Used
D22	Canada	CAD	Montreal	Carrier Used	Carrier Used
D23	USA	USD	New York, Boston	Air India	AI
D24	USA	USD	Chicago	Carrier Used	Carrier Used
D25	USA	USD	San Francisco, Los Angeles	Carrier Used	Carrier Used
D26	USA	USD	Atlanta, Houston	Carrier Used	Carrier Used
D27	Germany	EURO	Munich, Koln, Dusseldorf, Hannover, Hamburg, Stuttgart, Darmstadt, Manihem, Nurnberg	Lufthansa	LH
D28	Germany	EURO	Frankfurt	Lufthansa	LH
D29	Germany	EURO	Berlin	Lufthansa	LH
D30	Switzerland	SFR	Basle, Zurich, Geneva	Swiss World Cargo	LX
D31	Spain	EURO	Barcelona	Emirates	EK
D32	Australia	AUD	Sydney	Qantas Airlines	QF
D33	Australia	AUD	Melbourne	Qantas Airlines	QF
D34	Australia	AUD	Perth	Qantas Airlines	QF
D35	Czech	EURO	Prague	Lufthansa	LH
D36	Hong Kong	HKD	Hong Kong	Air India	AI
D37	New Zeland	NZD	Auckland	Carrier Used	Carrier Used
D38	Russia	USD	Moscow	Carrier Used	Carrier Used
D39	South Korea	USD	Kimpo International, Incheon	Air India	AI
D40	Finland	EURO	Helsinki	Finnair Cargo	AY
D41	Romania	EURO	Bucharest	Carrier Used	Carrier Used
D42	Norway	EURO	Oslo	Carrier Used	Carrier Used
D43	Ireland	EURO	Dublin	Carrier Used	Carrier Used
D44	Israel	USD	Tel Aviv	El Al Israel	LY
D45	UAE	USD	Dubai	Air India	AI
D46	Oman	USD	Muscat	Air India	AI
D47	Egypt	USD	Cairo	Carrier Used	Carrier Used
D48	Taiwan	USD	Taipei	Carrier Used	Carrier Used
D49	Ukraine	USD	Kiev	Lufthansa	Carrier Used
D50	China	USD	Shanghai, Shenzhen	Carrier Used	Carrier Used
D51	Philippines	USD	Manila	Carrier Used	Carrier Used
D52	Malaysia	USD	Kualalumpur, Pe Nang	Malaysia Airlines	Carrier Used
D53	Cyprus	USD	Larnaca	Carrier Used	Carrier Used
D54	South Africa	USD	Johannesberg, Durban	Carrier Used	Carrier Used
D55	Slovakia	EURO	Bartislova	Lufthansa	LH
D56	Saudi Arabia	SAR	Riyadh	Saudi Arabia Airlines	SV
D57	Turkey	EURO	Istanbul	Turkish Airlines	TK
D58	Thailand	USD	Bangkok	Thai Airways	TG
D59	Brazil	USD	Sao Paulo, Rio De Janeiro	Emirates	EK