TECHNICAL SPECIFICATION FOR

ELECTRICAL, CONTROLS & INSTRUMENTATION

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1. GENERAL SPECIFICATION FOR ELECTRICAL, CONTROLS & INSTRUMENTATION:

a) ELECTRICAL, CONTROL & INSTRUMENTATION (E,C&I) scope of work by system vendor, scope of work between BHEL & VENDOR, Scope of supply for the system between BHEL and Vendor shall be as mentioned in this specification.

b) The vendor shall provide all necessary inputs to enable the Purchaser (BHEL) to design & procure the LT MCC, PLC etc., for the system.

c) General site conditions are furnished under “Project Information” elsewhere as part of these specifications or associated specifications. All E,C&I equipments shall be suitable for the site conditions indicated therein. All electrical equipment shall be suitable for the power supplies, fault levels and other climatic conditions indicated in “Project Information” enclosed with the specification.

d) The System shall be designed suitable for Auto Operation through a Programmable Logic Controller (PLC) system to be arranged by BHEL. This PLC system will cover the requirements of the Ultra Filtration (UF) system of filtration plant. The system vendor shall provide necessary Electrical, Control & Instrumentation equipments, Pneumatic Operated Valves (POVs), Control Valve etc. in his plant to facilitate auto operation.

e) The system vendor should furnish a " Write up on Control Description" explaining the controls, interlocks etc., for the system which have to be arranged by the purchaser in the PLC system. Necessary Valve Sequence Charts, Logic Diagram control philosophy, list of interlocks etc., have to be furnished during detailed engineering to facilitate implementation of the system controls & interlocks in the PLC system.

f) Based on the inputs furnished by system vendor, the PLC vendor will prepare the engineering software in the form of ladder diagrams for the system portion. The system vendor shall review and approve the ladder diagram for implementation. At this stage of checking & approval the system vendor should not call for any considerable number of additional I/Os over & above the I/O list given in his offer. Once the system requirements are implemented in the PLC system after vendor’s review & approval, the responsibility for proper functioning of the entire system in Auto & Manual mode shall rest with the vendor.

g) Analytical instruments for pH / ORP / Conductivity / Silica / Turbidity / TOC / Dissolved Oxygen etc. as applicable shall consist of sensor & microprocessor based analyser which shall be located in the field. Only 4 - 20mA output signals from the analysers shall be brought to the PLC system where these parameters will be displayed on the PC screens using HMI software. Necessary calibration solutions / buffer powders / reagents etc. required for calibration & commissioning of analytical instruments shall be included by the vendor in his scope. The offer should include rates for such calibration solution / buffer powder / reagents and the periodicity and quantity requirement.

h) To facilitate operation of the system, valve operation shall be pneumatically operated. Accordingly vendor to indicate the Instrument air requirement taking into consideration that at a time all the working streams shall be operated.

i) All the instruments supplied by the vendor must meet BHEL's specification and will have to be procured from the approved vendors list only.

j) The detailed specification of various electrical / control equipments and supply system are given in the respective sections of this specification or attached customer specification.

Additional requirements

a) During execution stage, the bidder shall assist BHEL for obtaining the approval for various drawings / data sheets / documents pertaining to this package by visiting customer's premises along with the buyer

b) The bidder shall supply all necessary calibration standard solutions / instruments as required for commissioning and until handing over the system to the end user.

c) All instruments shall be offered to purchaser Engineers for inspection. Any instrument shall be dispatched from manufacturer's works only after obtaining written clearance from BHEL.

d) After award of contract of bidder should submit the quality plan for BHEL approval for all the items covered in this package. O& M manuals for all the Instruments should be submitted in Hard & soft copies. (After award of contract)

e) All mounting accessories for various instruments shall be supplied as a part of basic scope of this package.

f) Erection hardware like root valves, impulse lines, 2 / 3 / 5 way manifold valves shall also be supplied as a part of basic scope of this package.

g) All Electrical equipments and instruments shall be provided with suitable earthing terminals as per relevant IS standard.

h) Instrument air will be made available at one point. Further distribution shall be taken care of by the system vendor.

i) The specification for Instruments, cables, instrument accessories shall be as per enclosed specification.

j) Tag numbering philosophy would be uniform for the entire plant. There would a single, unique tag for a given equipment / signal.

k) After completion of all erection and commissioning works, the left out items/ spares / tools & tackles / calibration instruments etc. shall be handed over to BHEL site office.

l) All instruments shall be type-tested type. Only type tested instruments shall be supplied.

m) All instruments shall undergo all routine tests. Test certificates for all supplies shall be furnished.

GENERAL INSTRUCTIONS TO THE TENDERER

a) Vendor shall quote for complete work specified in the document. Incomplete quotations for the part of the work will not be considered even if the quoted rates / price is lower.

b) Vendor shall contact owner / consultant and obtain additional details / data if any required to submit proper quotation.

c) The owner reserves the right to omit any one or more items of work at any time of the contact without assigning any reason what so ever.

d) The vendor shall include all necessary commissioning spares in his basic scope of supply.

e) Re calibration of all Rectification / repair / replacement of defective components. This will be part of basic scope.

f) After commissioning the instruments to the satisfaction of the end user (BHEL / Customer) the successful bidder shall extend support to BHEL & (BHEL Customer) for a period of three months from the date of Commissioning for the following.

i) Recalibration of all instruments whenever required.
ii) Rectification / Repair / Replacement of defective components

2. ELECTRICAL AND C&I SYSTEM ACTIVITIES

SL. NO	ELECTRICAL, C&I SYSTEM ACTIVITY BY THE VENDOR
a)	Design, Manufacture / procurement, testing at manufacturer's works, packing delivery of the instruments, Instrument cables, cable Trays Solenoid Valve Enclosure Box , Junction Boxes and valve actuators to site for complete skid.
b)	Obtaining approvals from end customer for the specification, makes, model numbers of the instruments, GA drawing,
c)	Furnishing the Inputs required for LTMCC engineering such as Electrical Load list with KW rating, number of drives covering all dosing pumps, dosing mixers in BHEL Format.
d)	Furnishing the Inputs required for PLC engineering such as Sequential Flow Chart, Control philosophy, Detailed IO list, Alarm list for the system
e)	Furnishing the data sheets for Instruments in BHEL Format.
f)	Furnishing the GA drawings & Termination details of Junction Boxes(JB's), Solenoid Valve Enclosure Boxes(SVEB's)
g)	Furnishing the Interconnection drawing of Instrument to Junction Box(JB's) in BHEL format.
h)	Furnishing the Interconnection drawing of Pneumatic Valves to Solenoid Valve Enclosure Box(SVEB's) in BHEL format.
i)	Preparation of Instrument Hook-up & installation drawings
j)	Supply of LT motor along with cable glands & lugs
k)	Supply of instruments as per enclosed PID along with support structures for the complete UF membrane skids, including UF dosing skids, UF CIP system.
l)	Supply of Pneumatic Operated Valves (POV's)as per enclosed PID
m)	Supply of required Junction Boxes (JB's) along with support structures for all supplied instruments
n)	Supply of required Solenoid valve enclosure Box (SVEB) for grouping of Pneumatic Operated Valves and supply of solenoid valve for individual POV along with support structures
o)	Supply of Instrument Cables from instruments, POV's (limit switch, solenoids) to JB's
p)	Supply of Cable Trays along with support structures (from Instruments to JB's and POV's to JB's)
q)	Supply of Cable Glands, cable lugs for instruments, motors, Junction Boxes(JB's), Solenoid Valve Enclosure Boxes(SVEB's) including the cable glands & cable lugs for the incoming cables in BHEL scope.
r)	Supply of Instrument airline header distribution (GI Rigid pipe, bends, tees, isolation / Drain valves etc.) from BHEL terminal point
s)	Supply of required erection materials for instrument Air line from Solenoid valve enclosure box to POV's (¼" OD SS tube, Air filter regulator, SS Tube, Fittings, Perforated trays for impulse tube, supporting materials etc)
t)	Supply of required erection materials for Instruments impulse line

	(Root valves, 2 / 3 / 5 Way manifold for instruments, Drain valves, ½" SS316 SSL Tube, SS Fittings, Perforated trays for impulse tube, supporting structure etc)
u)	Supply of VFD panels
v)	Supply of Mandatory spares as per enclosed list.
w)	Supply of Commissioning spares as per enclosed list.
x)	Universal Handheld HART Communicator with charger suitable for supplied instruments- 2Nos
y)	Obtaining all necessary statutory clearance for the installation
z)	Calibration of all instruments at site with standard calibration solutions & standard instruments
aa)	Supply of tools required for erection & commissioning of instrumentation system
bb)	Carrying out pre commissioning Checks & test at site
cc)	Commissioning and putting into satisfactory operation of all instruments at site including successful of trial operation and handing over the system to end user (Customer)
dd)	Providing training to BHEL & End user (BHEL Customer) at site
ee)	After commissioning the instruments to the satisfaction of the end user (Customer) the successful bidder shall extend support to BHEL & Customer for a period of three months from the date of commissioning for the following. a) Recalibration of all instruments b) Rectification / Repair / Replacement of defective components
ff)	Submission of Operation & Maintenance manual in required number of copies.
gg)	Furnishing unit price of various components for addition / deletion purpose for all components of instruments, erection accessories.

3. ELECTRICAL AND C&I SCOPE OF SUPPLY

The list of items to be included in bidder scope includes but not limited to the following.

SL. NO	ELECTRICAL, C&I SYSTEM
a)	Supply of LT motor along with cable glands & lugs
b)	Supply of instruments as per enclosed PID along with support structures.
c)	Supply of Pneumatic Operated Valves (POV's) as per enclosed PID.
d)	Supply of required Junction Boxes (JB's) along with support structures for all supplied instruments
e)	Supply of required Solenoid valve enclosure Box (SVEB) for grouping of solenoids of Pneumatic Operated Valves and supply of solenoid valve for individual POV along with support structures as required
f)	Supply of Instrument Cables from all instruments to JB's and POV's (limit switch, solenoids) to JB's
g)	Supply of Cable Trays along with support structures (from Instruments to JB's and POV's to SVEB's)
h)	Supply of Cable Glands, cable lugs for instruments, motors, Junction Boxes(JB's), Solenoid Valve Enclosure Boxes(SVEB's) including the cable glands & cable lugs for the incoming cables in BHEL scope.
i)	Supply of Instrument airline header distribution (GI Rigid pipe, bends, tees, isolation / Drain valves etc.) from BHEL terminal point
j)	Supply of required erection materials for instrument Air line from Solenoid valve enclosure box to POV's (¼" OD copper tube, Air filter regulator, SS Tube, Fittings, Perforated trays for impulse tube, supporting materials etc) covered above
k)	Supply of required erection materials for Instruments impulse line (Root valves, 2 / 3 / 5 Way manifold for instruments, Drain valves, ½" SS316 SS Tube, SS Fittings, Perforated trays for impulse tube, supporting structure etc) covered above
l)	Supply of VFD panels
m)	Supply of Mandatory spares as per enclosed list.
n)	Supply of Commissioning spares as per enclosed list.
o)	Universal Handheld HART Communicator with charger suitable for supplied instruments- 2Nos
p)	Additional One number of electromagnetic flow transmitter (sensor and transmitter) same as the one supplied for common permeate outlet.

4. ELECTRICAL AND C&I SCOPE OF WORK BETWEEN BHEL & VENDOR

SL. NO	ELECTRICAL SYSTEM	ACTIVITY	AGENCY
a)	415V MCC PANEL	SUPPLY ERECTION	BHEL BHEL
b)	LT POWER CABLE FOR MOTORS AND INSTRUMENT POWER SUPPLY(230 V)	SUPPLY ERECTION	BHEL BHEL
c)	CONTROL CABLES AND INSTRUMENTATION CABLES BEYOND JUNCTION BOX (JB)	SUPPLY ERECTION CHECKING	BHEL BHEL BHEL
d)	SPECIAL CABLES(REFER NOTE 4)	SUPPLY ERECTION	VENDOR VENDOR
e)	CABLING MATERIAL (CABLE TRAYS, SUPPORT MATERIAL ACCESSORIES, CONDUITS ETC.) BEYOND JB.	SUPPLY ERECTION	BHEL BHEL
f)	START STOP PUSH BUTTON STATION FOR MOTORS	SUPPLY ERECTION	BHEL BHEL
g)	EQUIPMENT EARTHING	SUPPLY ERECTION	BHEL BHEL
h)	JUNCTION BOXES	SUPPLY ERECTION	VENDOR VENDOR
i)	LAYING & TERMINATION OF DIGITAL / ANALOG INSTRUMENT CABLES / CONTROL CABLES BETWEEN EQUIPMENT & JUNCTION BOXES.(EXCEPT SUPPLY OF INSTRUMENT/ANALYSER POWER CABLES)	SUPPLY ERECTION CHECKING	VENDOR VENDOR VENDOR
j)	CABLING MATERIAL BETWEEN EQUIPMENT & JUNCTION BOX (CABLE TRAYS & ACCESSORIES)	SUPPLY ERECTION	VENDOR VENDOR
k)	CABLE SCHEDULE & CABLE INTERCONNECTION DRG.(UPTO JB)	PREPARATION VETTING	VENDOR BHEL
l)	BELOW GROUND EARTHING, LIGHTING, A/C AND VENTILATION	SUPPLY ERECTION	BHEL BHEL
m)	CONTROLS AND INSTRUMENTATION (As per P & ID enclosed and additional flow transmitter as mentioned in Cl. 4 p))	SUPPLY ERECTION COMMG.	VENDOR VENDOR VENDOR
n)	PLC SYSTEM – SYSTEM VENDOR TO EXTEND TECH. ASSISTANCE FOR PUTTING THE SYSTEM IN AUTO	SUPPLY ERECTION TECHNICAL ASSISTANCE	BHEL BHEL VENDOR

o)	INSTRUMENT AIR LINE DISTRIBUTION	SUPPLY ERECTION COMMG.	VENDOR VENDOR VENDOR
p)	IMPULSE PIPING AND FITTINGS	SUPPLY ERECTION COMMG.	VENDOR VENDOR VENDOR
q)	LOCAL PANEL FOR INSTRUMENTS, TRANSMITTER RACKS ETC.(IF APPLICABLE)	SUPPLY ERECTION COMMG.	VENDOR VENDOR VENDOR
r)	CALIBRATION OF INSTRUMENTS		VENDOR

NOTES:

1. Necessary layout inputs shall be given for vendor supplied equipments.
2. Cable gland & Lugs shall be provided by vendor for equipment supplied by vendor.
3. Cable glands shall be matching to cable sizes where cables are supplied by purchaser. Cable sizes shall be furnished to the vendor at detailed Engineering stage.
4. Cables other than Power, Control & Screened control cables are special cables (cable between sensor & analyser).
5. Erection of cables beyond junction boxes shall be in purchaser's scope.
6. Termination of cables at Vendor supplied equipments by vendor, upto Junction Box.
7. All field instruments and junction boxes shall be provided with prefabricated canopy made of GI sheet with bolted construction.

5. LIST OF DRAWINGS / DOCUMENTS TO BE SUBMITTED ALONG WITH OFFER.

The bidder shall submit the following documents along with the offer:

a) Signed conformation of BHEL specification in total for the subject enquiry.

b) Instrument Schedule indicating instrument type, location, Quantity, operating parameters, measuring range, power rating ,Makes in BHEL Format

c) Vendor P & ID

d) I / O list with number of DI, DO, AI, AO required for entire package

e) Preliminary VFD Panel GA drawings .

f) Electrical Load List indicating KW rating and no. of drives shall be furnished along with offer

g) Unit price for addition / deletion purposes during detailed design commissioning at site (in a separate sealed cover).

h) Schedule of Technical Confirmations – Schedule-A

i) Schedule of Technical deviations(ifany) – Schedule-B

6. LIST OF DRAWINGS / DATA SHEET TO BE SUBMITTED AFTER PLACEMENT OF PURCHASE ORDER

The following documents shall be submitted for the approval of the purchaser, for all items under the scope of supply:

a. Data Sheet for Medium Voltage Squirrel Cage Induction Motor as per enclosed format
b. Datasheet of VFD
c. Detailed I / O list
d. Data Sheet for Instrument signal Cables.
e. Datasheet for Pneumatic operated Valves.
f. Type and quantity of cable trays supplied
g. Trouble shooting manual and maintenance manuals
h. Maintenance instructions for trouble shooting, routine adjustments, assembly & disassembly instructions, off-line testing
i. O&M manual 6 copies of all items (for information).
j. Technical data sheet for all instruments supplied in BHEL Format
k. List of commissioning spares
l. List of Tools & tackles
m. List of calibration tools & Instruments
n. Datasheet, Dimensional drawings, mounting / installation drawings, materials of construction, Terminal Drawing for Junction Boxes supplied
o. Datasheet,Dimensional drawings, mounting / installation drawings, materials of construction, Terminal Drawing for Solenoid Valve Enclosure Boxes supplied
p. Test certificates for all supplied items including but not limited to Instruments, cables, Junction Boxes, Solenoid valve Enclosure Boxes, VFD panels.
q. Instruments, POV's Installation and Hookup drawings for all items

7. PROJECT INFORMATION:

Refer ROS 6166 for details

8. CUSTOMER SPECIFICATION FOR ELECTRICAL C&I

The specification shall be read along with **enclosed customer specification (Annexure-1)** and the vendor shall comply to these specifications as a minimum requirement.

a) The Bidder shall provide all systems, equipment, accessories and associated equipment, which are included in Bidder's scope, in a fully operational condition acceptable to the Owner. The Bidder shall also provide all material, equipment and services which may not be specifically stated in the specifications but are required for completeness of the equipment/systems furnished by the Bidder and for meeting the intent and requirements of this specification. The work shall be consistent with modern power plant practices and shall be in compliance with all

applicable codes, standards, guidelines and safety requirements in force on the date of award of the contract.

b) All Instruments which are Integral to equipment like pumps, motors etc., which are not indicated in enclosed P & IDs but required for control, monitoring and operation of the equipment/plant/ Systems are to be provided. All the instruments shall be provided by the Bidder to meet actual system requirements subject to Owner's approval.

c) Further, all the instruments including transmitters, temperature elements which are required to implement the control philosophy as specified in corresponding mechanical section shall also be provided by the Bidder within the quoted lump sum price.

d) Process instruments (other than instruments integral to the equipment's like pumps, motors etc) , which are, required for the protection of more than one equipment as well as protection signals for important Drives , DUAL redundant instruments shall be provided.

e) All the temperature elements (RTD's , T/C's etc.) other than those used for protection & control are to be provided with single input type temperature transmitters. Temperature element (RTD's , T/C's etc.) used for protection & control are to be provided with Dual Input temperature transmitter.

f) Two (2) nos of hand held type calibrator shall be provided for adjustment/ calibration / maintenance of the HART compatible transmitters.

9. SPECIFICATION FOR LT MOTORS

The specification for LT motors shall be referred in enclosed specification ROS 4159 and the referred customer specification enclosed therein as a minimum requirement.

10. SPECIFICATION FOR INSTRUMENTS

The specification shall be read along with enclosed customer specification and the vendor shall comply to these specifications as a minimum requirement.

a) Measuring instruments/equipment and subsystems offered by the Bidder shall be from reputed experienced manufacturers of specified type and range of equipment, whose guaranteed and trouble free operation has been proven. Further, all instruments shall be of proven reliability, accuracy, and repeatability requiring a minimum of maintenance. They shall comply with the acceptable international standards and shall be subject to Employer's approval. All instrumentation equipment and accessories under this specification shall be furnished as per technical specifications, ranges, makes/numbers as approved by the Employer during detailed engineering

b) Every panel-mounted instrument requiring power supply shall be provided with a pair of easily replaceable glass cartridge fuses of suitable rating. Every instrument shall be provided with a grounding terminal and shall be suitably connected to the panel grounding bus.
c) All local gauges as well as transmitters, sensors, and switches for parameters like pressure, temperature, level, flow etc. as required for the safe and efficient operation and maintenance as well as for operator and management information (including all computation) of equipment under the scope of specification shall be provided on as required basis within the quoted lump sum price. For bidding purpose, tentative minimum instruments have been indicated on the P&IDs. However, contractor shall supply any additional local gauges /switches /transmitter./ sensors for reasons mentioned above without any additional cost to the Employer.
d) For sea water applications, all instruments applications, they shall be provided with wetted parts made of Monel/ Hastelloy C or any other material (if provenness experience of the proposed material for such applications is established by contractor)
e) For coastal areas, all instruments shall be provided with durable epoxy coating for housings and all exposed surfaces of the instruments.
f) For interrogation of potential free Contacts, 24V DC power supply shall be employed.
g) Instruments for sensing, transmission and measuring system shall be of electronic type with signal transmission in current mode of 4-20 mA DC. It shall be of 2 wire type for Pressure, Flow (Paddle wheel). It shall be of 4 wire type for Turbidity, Flow (Electromagnetic),SDI.
h) Hookup drawings for instrument mounting shall be furnished by bidder.
i) Any special accessory(including special cables) or fittings required for instrument from OEM of instrument shall supplied along with the instrument.
j) All instruments shall be calibrated strictly as per manufacturer's instructions prior to installation. The scope of calibration includes all field and control room instruments of all types namely, pneumatic, electronic, electrical etc. Any re-calibration requirement before handing over shall also be included in bidder scope..

10.1. SELECTION OF RANGES FOR INSTRUMENTS

The ranges of the instruments shall be selected based on the following Philosophy Indicated below:

a) For pressure measurements, the maximum operating pressure will be Within 70 to 80% of the maximum scale range. All pump suction measurements will cover the negative pressure range also.
b) For flow measurement, the maximum range shall be fixed at about 10 to 15% above the maximum operating flow.
c) For electrochemical measurements the maximum Range will be around 10 to 15% higher than the recommended alarm settings.

10.2. SPECIFICATION FOR PADDLE WHEEL TYPE FLOW TRANSMITTER

Sl.No	Features	Requirement
a)	Flow Sensor: Type	Paddle Wheel, On-line
b)	Material – Body / Rotor / Rotor pin / O-ring	suitable for the medium
c)	Installation fitting Type Material	Saddle / Weld-on nipple depending on line size.-to be provided by the bidder To suit the pipeline material
d)	Sensor Overall Length	To suit the pipe line size
e)	Cable Length from sensor to Indicator	10 m (Min.).
f)	Thread size on sensor cap	To suit the thread on the saddle / Weld-on nipple.
	Indicator	
g)	Type	Digital
h)	Scale/Range	As per process requirment
i)	Mounting	Field mount type. All mounting accessories to be provided
j)	Housing material	Bidder to state
k)	Protection	IP 55, weather proof
l)	Power Supply	24 V DC
m)	K factor	Bidder to inform
n)	Accuracy	±1% of full scale
o)	Output	4-20 mA DC (Analog)

a) Mounting bracket shall be supplied for Pipe / Rack mounting of the indicator.
b) The upstream & downstream straight length requirements for the flow sensor shall be indicated in the offer.

10.3. SPECIFICATION FOR SDI ANALYSER

a)	Power	230 V,50 Hz
b)	Output	4-20 mA
c)	Mounting	Wall/Panel mounted
d)	Display	Required-LCD
e)	Operation	Online-Automatic
f)	Enclosure	IP 53 or better
g)	Range	As per process requirement

The analyser shall be provided as a complete assembly with all required accessories,reagents,filter paper etc from proven/reputed make. Pressure booster as per requirement, shall be provided.

10.4. SPECIFICATION FOR FLOW SWITCH

Flow Switches shall be with paddle & bellows sensors with paddle MOC of SS316 & Bellows MOC SS 316L. Wetted parts shall be SS316 or as suitable for the application. Enclosure shall be Die Cast Aluminuim with weather proof to IP66 and suitable for ambient temp of 50 deg C. Mounting shall be vertical/direct on line. Electrical connection shall be plug and socket. Process connection suitable for line size shall be selected. Range shall be suitable for process requirement. The switches shall be SNAP acting Micro Switches suitable for 240V AC, 15A with 2 NO + 2 NC (min) Dry Contact. The set point adjustability should be over the full range.

10.5. LEVEL GAUGES- FLOAT & BOARD TYPE

a)	Function	Indicate, level measurement of liquid
b)	Type-construction	Guided- direct indication
c)	Measuring range	DDE
d)	Float	SS316/PP
e)	Float & guide wire rope	SS 316/PP
f)	Anchor plate	SS316/PP
g)	Name plate & tag	SS
h)	Moc of accessories for gauge	Suitable for seashore environment
i)	Process connection	3 nos of 25 NB ANSI B 16.5 150# soff flange, ss
j)	Least count	5 mm
k)	Calibrated gauge board	Min 6" wide x Al white powder coating with black graduations & numericals
l)	Accessories for gauge	Suitable for seashore environment
m)	Spring tensioner assly.	Steel spring housed in steel enclosure (cad.plated)

11. SPECIFICATION FOR VFD PANELS

11.1. CODES AND STANDARDS

Motor IS: 4722/IS: 325/IEC: 60034/NEMA 30 & 31
VFD IEC: 60034/ IEC: 61800
Harmonics & EM compatibility IEEE: 519/IEC: 61000
Contactor/Switches/Fuses etc. IEC: 60947, IS: 13947

11.2. OPERATING CONDITIONS

a) For the purpose of design of equipment/systems, an ambient temperature of 50 deg. Centigrade and relative humidity of 95% shall be considered.

b) All equipment shall be suitable for rated frequency of 50 Hz with a variation of +3% & -5%, and 10% combined variation of voltage and frequency unless specifically brought out in the specification.
c) All the equipment, material and systems shall, in general, conform to the latest edition of relevant National and international Codes & Standards, especially the Indian Statutory Regulations.
d) The auxiliary AC voltage supply arrangement shall have 415V systems. It shall be designed to limit voltage variations as given below under worst operating condition:415V : +/- 10% Note: The Voltage level mentioned above is the Nominal Voltage available at the input of the VFD System from the MCC/ Switchgear/transformer, based on the system requirement/Availability. The voltage level for the VFD shall be 415V , Low Voltage, Three Phase AC Note: The voltage level mentioned above is the Nominal Voltage which is fed to the motor from the VFD.

11.3. SYSTEM DESCRIPTION

The VFD System shall include the following equipment for each drive.
a) Power/control panels consisting of line converters, inverters and control system for drive including complete control & protection of drive and the motor.
b) Breaker/Contactor on the VFD/Motor/Transformer/CT/PT/Meters with complete Control, Protection and Diagnostics features of the VFD, as per system requirement.
c) DC air core reactor or capacitor, as per the system requirement.
d) Inverter Duty Motor suitable for VFD application

11.4. GENERAL REQUIREMENTS

a) The Variable frequency drive (VFD) system shall be of a modern proven design for similar applications in power plants/industry. The system shall be either Current Source Inverter (CSI) or Voltage Source Inverter (VSI) type with Six (6) pulse design
b) The system shall be fully digital, PLC/Microprocessor based, energy efficient, and shall provide very high reliability, high power factor, low harmonic distortion and low vibration and wear and noise. It shall be easy to install in minimum time and expense and no special tools shall be required for routine maintenance.
c) The offered equipment shall be with state of art technology and proven field track record. No prototype equipment shall be offered.
d) The VFD model offered shall be from the existing VFD model series in the regular manufacturing range of the manufacturer. Along with the offer the Vendor shall submit the supply record and satisfactory performance record for 2 (two) years running of the offered VFD supplied in India or abroad.
e) The VFD manufacturer shall ensure the proper coordination of their VFD with the Driven Motor and the Employer`s system. All the Motors which are to be driven by VFDs will be of Inverter duty type. The VFD operation shall have no inherent detrimental impact on the Motors/ cables & employer`s system.

f) Vendor shall ensure availability of spare parts and maintenance support services for the offered equipment for at least for 15 years from the date of supply. After this period, if vendor discontinues the production of spare parts, vendor shall give at least twelve (12) months' notice prior to such discontinuation so that owner may order his requirements of spares in one lot. The offered VFD manufacturer should have their maintenance service & spares supply network in India to provide quick maintenance service & Spares supply support. The vendor shall indicate the source for supply of spares & Maintenance service location in India.

11.5. TECHNICAL AND OPERATIONAL REQUIREMENTS

a) The system shall be designed to deliver the motor input current and torque for the complete speed torque characteristics of the driven equipment, with maximum input supply voltage and frequency variation. The system shall be suitable for the load characteristics and the operational duty of the driven equipment.
b) The overload capacity of the controller shall be 110% of rated current for one minute for variable torque applications at rated voltage. If the motor load exceeds the limit, the drive shall automatically reduce the frequency and voltage to the motor to guard against overload.
c) The drive system shall be designed to operate in the following operating modes as to suit characteristics of the driven equipment or specified by the load:
   a. Variable torque changing as a function of speed.
d) VFDs shall comply with the latest edition of IEEE 519 & IEC 61000 for both individual as well as total harmonic voltage and current distortion limits. The Voltage and Current limits shall be applicable at the Point of Common Coupling (PCC)
e) The compliance shall be verified by the contractor by Harmonic studies conducted with maximum and minimum fault level, cable capacitance, system equipment reactance etc. Finally, the compliance shall be verified by the field measurements of harmonics at the PCC with and without VFDs operation
f) VFD shall be capable of withstanding the thermal and dynamic stresses and the transient mechanical torque, resulting from short circuit. Any damage resulting from such a short circuit or internal fault shall be limited to the component concerned.
g) The system shall be suitable to maintain speed variation within range 10-110% with speed set accuracy of +1% of rated maximum speed and steady state regulation of +0.5% of rated speed as per system requirement.
h) The VFD System shall maintain a power factor of 0.95 (minimum) from 25 % to 100 % of rated speed.
i) Maximum allowable audible noise from the VFD system will be 85 dB (A) at a distance of one meter under rated loaded with all cooling fan operating conditions.

11.6. VFD COMPATIBILITY WITH THE MOTOR

a) The system design shall not have any inherent output harmonic resonance in the operating speed range.

b) VFD shall provide stable operation of motor from high-voltage dv/dt stress, regardless of cable length to motor. The vendor shall clearly state the limitations in the motor cable distance in his proposal. The approximate cable length is 100 m for each motor. If the cable length becomes critical, filters/ chokes etc. shall be provided by the VFD manufacturers as an integral part of the VFD to mitigate the reflected wave effect of harmonics.

11.7. EFFICIENCY

Efficiency (Drive only) shall be minimum 98%. Overall efficiency shall be minimum 96.5% at rated load and speed. Overall Efficiency evaluation shall include input transformer, harmonic filters and power factor correction (if applicable), VFD converters, cooling fans and output filter, as applicable in the system. Auxiliary controls, such as internal VFD control boards, cooling fans/pumps.
In absence of valid test report, a factory test shall be performed at the VFD manufacturer's facility verifying the efficiencies. Manufactures who are supplying Drive and transformer from different locations, efficiency test will be conducted separately for Drive and transformer.

11.8. COOLING SYSTEM

a) The VFD shall be designed to operate indoor under temperature range of 0 deg C to 50 deg C and relative humidity of 95%.
b) VFD manufacturer to primarily offer Air cooled Design.
c) In case of Air cooled design, the VFD Cooling system shall be such that it puts minimum heat load inside the room. The Cooling system shall be designed in such a way that the Air Conditioning & Ventilation Air requirements are kept to minimum. The VFD Manufacturer shall furnish the data regarding heat load, air flow requirements during the detailed engineering.
d) Air cooled VFDs shall be provided with cooling fans mounted integral to the VFD/ enclosure. The VFD shall include air-flow pressure switches and temperature detectors to monitor proper operation of the air cooling system. If the fan fails, the system must generate the alarm/trip for the fan failure.

11.9. POWER CONVERTER

a) The static power converter shall consist of a line side converter for operation as a rectifier and a load side power converter for operation as a fully controller inverter. Power converter shall be fast switching, most efficient and low loss type.
b) The converter shall be co-ordinated with the transformers. The converter shall be able to withstand a three phase short circuit current until interrupted by normal breaker operation.
c) Adequate short circuit and over voltage protection shall be provided for the converter and inverter system.
d) All power converter devices shall include protective devices, snubber networks and dv/dt networks as required.
e) The current rating of the converter's semi-conductor components shall not be less than 120% of the nominal current flowing through the elements at full

load of the VFD through the whole speed range. If the parallel connection of semiconductor is applied, the above current rating shall not be less than 140% of the above values.

f) All power diodes shall be of silicon type with minimum VBO rating at 2.5 times the rated operating voltage.

g) The power converter circuit shall be designed so that motor can be powered at its full nameplate rating continuously without exceeding its rated temperature rise nor reducing its service factor due to harmonic currents generated by the inverter operation. The conversion devices and associated heat sinks shall be assembled such that individual devices can be replaced without requiring the use of any special precautions / tools.

h) The cooling system of the electronic components, if provided, shall be monitored and necessary alarms shall be provided to prevent any consequential damage to the power control devices.

11.10. DC LINK CAPACITOR (AS APPLICABLE):

a) Capacitor shall be of self-healing film or electrolytic type having high life time. The capacitor shall be an integral part of VFD system. DC link Capacitors shall have discharge resistors which shall be capable of reducing the residual charges to zero just after the capacitor is disconnected from the supply source. The capacitor shall be suitable for high ripple currents.

11.11. ENCLOSURE

a) Enclosure frames and load bearing members shall be fabricated using suitable mild steel structural sections or pressed and shaped cold-rolled sheet steel of thickness 2.0 mm. Frames shall be enclosed in cold-rolled sheet steel of thickness 1.6 mm. Doors and covers shall also be of cold rolled sheet steel of thickness 1.6 mm. Stiffeners shall be provided wherever necessary. The gland plate thickness shall be 3.0 mm for hot / cold-rolled sheet steel and 4.0 mm for non-magnetic material.

b) The cable entry shall be from the bottom of the panel and a removable bolted un-drilled gland plate.

c) All Panels shall be of dust-proof and vermin-proof construction and shall be provided with a degree of protection of IP: 4X as per IS/IEC 60947.

d) Enclosures must be designed to avoid harmonic and inductive heating effects and to shield any outside equipment from interference, enclosing and shielding the complete to eliminate any radio frequency interference. The construction of the panel shall provide effective protection against electromagnetic emissions.

e) Each panel shall be provided with illuminating lamp, space heater with switch fuse and variable setting thermostat.

11.12. PAINTING

Paint shade shall be as follows
a) Motors : RAL 5012 (Blue)
b) VFD Panels : Front and rear panels in Grey (RAL9002). End panel sides in blue (RAL 5012)
c) VFD reactor enclosure : RAL 5012 (Blue), legend in black letter(if applicable)

11.13. CONTACTOR

a) Type: Shall be SF6 or Vacuum type or air-break restrike free, stored energy operated and with electrical anti-pumping features.
b) These shall be electrically operated, mechanically latched type & shall have protection against over load, all AC/DC transients and voltage surges etc. Electronic control module shall be electrically isolated.
c) All other components, technical parameters shall be as per applicable IEC/IS.

11.14. MOTORS

a) VFD shall be used to drive three (3) phase squirrel cage inverter duty Induction motor with VPI insulation (Resin poor) suitable for VFD application. These motors shall be provided with insulated bearing on at least one side.
b) Motors shall also meet the requirements mentioned in subsection for motors and relevant IS/IEC18.03.00 Motor shall be suitable for operation with a solid state power supply consisting of an adjustable frequency inverter for speed control & shall be suitable for the current waveforms produced by the power supply including the harmonics generated by the drive.
c) Motor insulation shall be designed to accept the applied voltage waveform, within the Vpeak and dv/dt limits as per IEC-61800.
d) Drive manufacturer shall coordinate with the motor manufacturer for proper selection of the motor for the given load application and the output characteristics of the drive.

11.15. CABLES & CABLING

VFD Manufacturer shall submit cable sizing & selection criteria of drive cables including grounding/ earthing philosophy to address all the key issues such as EM Noise emissions, Common mode noise, voltage reflections, stray capacitances etc., for owner`s information.

11.16. CONTROL AND PERFORMANCE REQUIREMENTS

a) The VFD to provide an automatic current limiting feature to control motor currents during startup and provide a “soft start” torque profile for the motor load combination. Current and torque limit adjustments shall be provided to limit the maximum VFD output current and the maximum torque produced by the motor.
b) It shall be possible to vary the speed of the drive and control it in either Local or Remote mode. Local / Remote selection shall be done from VFD panel unless otherwise specified.
c) Provision shall be kept for exchange of information between different VFD control system parameters thru PLC/DDCMIS.

d) Drive shall be equipped with a front mounted operator console panel consisting of a backlit alphanumeric display and a keypad with keys for parameterization and adjusting parameter. Control panel shall be operable with password for changing the protection setting, safety interlock etc.
e) Operator console/Main Control Card shall have facility / port to connect external hardware such as Lap-Top etc. Console shall have facility for upload and download of all parameter settings from one drive to another drive for start up and operation.
f) User-friendly licensed software for operation and fault diagnostic shall be loaded in the drive system panel before commissioning.

11.17. PROTECTION FEATURES

The system offered shall incorporate adequate protection features, properly coordinated for the drive control and for motor including following:

a) Incoming and outgoing line surge protection.
b) Under / over voltage protection
c) Phase loss, phase reversal, overload, negative phase sequence, locked rotor protection.
d) Instantaneous Over current & Earth fault protection
e) Converter/Inverter module failure indication.
f) Over frequency/speed protection.
g) Ventilation failure indication & alarm.
h) Over temperature of VFD
i) Bearing temperature protection.
j) System earth fault protection.
k) Speed reference loss protection.

11.18. CONTROL FEATURES

Following controls shall be provided as a part of the Operator Control Panel or through separate switches on the front panel door.

a) Start / stop
b) Speed control (Raise / lower)
c) Acknowledge/Accept/ Test Push Button for annunciation
d) Auto / Manual
e) Emergency stop
f) Trip-Remote Breaker
g) Panel/Remote mode

11.19. DIAGNOSTIC FEATURES

a) The VFD shall include a microprocessor/PLC based digital diagnostic system which monitors its own control functions and displays faults and operating conditions.
b) Fault diagnostic shall be built into the system to supervise the operation and failure of the system. The information regarding failure of any of the system including shut down of the system shall be available. It shall be possible to retrieve the record of events prior to tripping of the system or de-energization. Auxiliary supply to the system components or to the electronics (firmware) for

the diagnostics / display shall be taken care of by the manufacturer for this purpose.

11.20. SERVICEABILITY / MAINTAINABILITY

a) Front Access: VFD system should be designed for front access only. Manufacturer shall state in his proposal if rear access is provided.
b) Power Component Accessibility: All power components in the converter sections shall be designed for rack-out accessibility for ease of maintenance and to minimize repair downtime.
c) Marking / Labeling: Sleeve type wire marker tags or other acceptable means of permanent identification shall be applied to power and control wiring. Individual labels shall be provided for all major components of the VFD system.

11.21. STORAGE AND PRESERVATION

a) The equipment should be suitable for storage for long periods before installation. Contractor should take adequate measures to ensure that no damage happens to the VFD System due to storage and preservation. Vendor shall submit powering requirement (if any) during storage.

11.22. TESTS

a) **ROUTINE TESTS**
All acceptance and routine tests as per the specification and standard IEC - 61800-2 and IEC 61800-4 shall be carried out.

b) **TYPE TESTS**
The Contractor shall submit for Employer's approval the reports of all the type tests as listed in this specification and carried out within last ten years from the date of bid opening. These reports should be for the tests conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client. In case the Contractor is not able to submit report of the type test(s) conducted within last ten years from the date of bid opening, or in case the type test report(s) are not found to be meeting the specification requirements, the Contractor shall conduct all such tests under this contract free of cost to the Employer and submit the reports for approval.

LIST OF TYPE TESTS

a) VFD panels
   i. Rated Current/ Output
   ii. Temperature rise test
   iii. Surge withstand capability test
   iv. Noise level test
   v. Power Loss Determination Test
   vi. Power factor measurement.

vii. Degree of Protection Test
viii. EMC Test

b) AC/DC Reactor (If applicable)
i. Lightning impulse test
ii. Heat run test
iii. Short time current test
iv. Noise level test

c) Induction motors
i. As per requirements mentioned in subsection for motor.

12. SPECIFICATION FOR INSTRUMENT CABLES

Refer the enclosed customer specification(Annexure-1)

13. SPECIFICATION FOR JUNCTION BOXES

Refer the enclosed customer specification(Annexure-1)

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14. SPECIFICATION FOR SOLENOID VALVE ENCLOSURE BOX (SVEB)

a) Each variant of the SVEB shall be supplied with required no. of Solenoid Valves (SOV), Air Filter cum Regulator (AFR), tubing with necessary fittings, mounting brackets, wiring, cable glands & lugs, Terminal Blocks (TBs) etc.
b) The solenoid valve coil wires shall be terminated in a terminal block located inside the enclosure box.
c) The inlet ports of the solenoid valves shall be connected to a common inlet manifold to which the air supply will be connected through an AFR.
d) The outlet / vent connections of the solenoid valve shall also be connected using SS 316 double compression type bulk head tube fittings.
e) Stickers have to be fixed for the SOV to indicate tag number. Separate Tag plates shall be mounted with plate screws for each outgoing impulse tube .Tag numbers shall be legibly inscribed on the tag plates. Tag numbers shall be provided during document approval stage after PO.
Inlet line size & common header: ½" mild steel Tube
Outlet line size (To POVs) : ¼" PVC coated copper tube
f) Enclosure material : 4mm thick Fiberglass Reinforced Polyester (FRP).
g) Enclosure protection IP: 55 minimum for indoor & IP-65 minimum for outdoor applications
h) Door gasket shall be of synthetic rubber
i) Earthing terminals: Two sets of Earthing bolts & nuts with lug shall be provided. Each shall be located at opposite points on outside of the SVEB with earth symbol.

j) Mounting fasteners : Suitable for mounting on walls, columns, structures etc. The brackets, bolts, nuts, screws, glands and lugs required for erection shall be of brass, included in Bidders scope of supply. Raceways shall be provided inside JBs for proper termination of cables.
k) Name Plate: Two numbers of lamicoid Name plate in white colour with inscription,as mentioned elsewhere in the specification, in black letters shall be fixed to the mounting bracket on top of the SVEB with plated screws.
l) The JB shall be of grey color RAL 7035
a) Suitable DIN rails along with clamps and screws shall be provided for terminal block mounting .All terminals are to be numbered serially by suitable identification label of PVC material in white background with black numbers. Terminal blocks shall be fixed to T.B supporting DIN rail by means of suitable end plates with screws. Terminal block shall be Melamine type having voltage grade 650 V (Minimum).
b) Manual over ride shall be provided for the solenoid valves.

15. SPECIFICATION FOR CABLE TRAYS, CABLE GLANDS, FITTINGS

Cable troughs shall be provided for branching out few cables from main cable route. These shall be U-shaped, fabricated of mild steel sheets of thickness 2 mm and shall be hot dip galvanised. Troughs shall be standard width of 50 mm & 75 mm with depth of 25 mm.

15.1. Cable glands

Cable shall be terminated using double compression type cable glands. Testing requirements of Cable glands shall conform to BS:6121 and gland shall be of robust construction capable of clamping cable and cable armour (for armoured cables) firmly without injury to insulation. Cable glands shall be made of heavy duty brass machine finished and nickel chrome plated. Thickness of plating shall not be less than 10 micron. All washers and hardware shall also be made of brass with nickel chrome plating Rubber components shall be of neoprene and of tested quality Necessary cable dimensions shall be furnished to the successful bidder.

15.2. Cable lugs/ferrules

Cable lugs/ferrules for power cables shall be tinned copper solderless crimping type suitable for aluminium compacted conductor cables. Cable lugs and ferrules for control cables shall be tinned copper type. The cable lugs for control cables shall be provided with insulating sleeve and shall suit the type of terminals provided on the equipments. Cable lugs and ferrule shall conform to DIN/IS standards.

16. PNEUMATIC ACTUATOR & ACCESSORIES FOR ON-OFF VALVE

a)	Quantity	01 No. for each Pneumatic Operated Valve (POV)
b)	Type	Pneumatic Rotary (Rack & Pinion)/Diaphragm type

		Double acting/Single acting as per process requirement
c)	Pressure	4-7 Kg /sq. cm
d)	Air Connection	¼" NPT(F) copper tube
e)	Hand wheel for manual operation	Required
f)	State of driven equipment on air failure	Stay put/Fail open/Fail close as per process requirement
g)	Torque capacity	Vendor to select to suit torque requirement of valve type,size & rating.
h)	Limit Switch	One for Open & one for Close position for each POV with 2 NO+2NC potential free contacts in each limit switch. Contact rating shall be 5A,240V AC , 0.5A, 220 V DC. Enclosure shall be weather proof IP 55. Limit Switch terminals shall be brought out to a Terminal with plug in connector.
i)	Drawings & Documents to be submitted	Datasheet and/or catalog with selected model number for a. Actuator b. Limit switch c. GA drawing of the complete valve-actuator-accessories arrangement d. Datasheet & O&M manual of actuator with Limit switch details.

17. PNEUMATIC ACTUATOR & ACCESSORIES FOR FLOW CONTROL VALVES

a)	Quantity	01 No. for each Pneumatic Operated Valve (POV)
b)	Type	Pneumatic Rotary (Rack & Pinion)/diaphragm Double acting/single acting as applicable
c)	Air Connection	¼" NPT(F) copper tube
d)	Hand wheel for manual operation	Required
e)	Torque capacity	Vendor to select to suit torque requirement of valve type,size & rating.
f)	Positioner	Smart type with HART communication protocol, With regulating input as 2 wire 4-20 mA(24 V). Housed in cast aluminium casing (with polyurethane paint); IP65 degree of protection for enclosure. Material of accessories shall be SS. The allowable drift rate will be +2% of set point/ hour maximum.The positioner shall be mounted on the actuator.

g)	Valve position transmitter	Required with output indicating position of valve as 2 wire 4-20 mA(24 V).
h)	Air Filter Regulator	Quantity: One for each valve. Type:Manual Drain Inlet :4 – 7 Kg / sq. cm Filtering particles: > 5 microns Filter Element:Sintered bronze/Phosphor Bronze/Polypropylene Output pressure: 0 – 7 Kg / sq. cm Output Gauge Range : 0-10 Kg/sq.cm Output Pressure Gauge dial: 50 mm Diameter. Blow down valve: To be provided Air connection Inlet :suitable SS316 end fittings to be provided for 1/4" NPT copper/SS tube.
i)	Drawings & Documents to be submitted	Datasheet and/or catalog with selected model number for a. Actuator b. Positioner c. Position Transmitter d. AFR e. GA drawing of the complete valve-actuator-accessories arrangement f. Datasheet & O&M manual of actuator, positioner, position transmitter and AFR.

18. MANDATORY SPARES

Sl.No	Item	Quantity
i.	Transmitters of all types and model no. (for the measurement of Pressure, differential pressure flow, level, etc.) including local indication(if applicable)	10% or 1 No. of each type and model whichever is more.
Temperature elements		
ii.	Temperature Transmitter	10% or 1 no. of each type whichever is more
iii.	RTD's*	1 no. of each type.
iv.	Thermo well	1 no. of each type.
v.	* (With head assembly, terminal block and nipple)	** (to be divided into various insertion lengths in proportion to main population)
Local Indicators(Non-Electrical type)-As applicable for the package as per the following items		
vi.	Temperature gauges	1 no. of each range and type
vii.	Pressure gauges	1 no. of each range and type
viii.	Differential Pressure Gauges	1 no. of each range and type

ix.	Level gauges	1 no. of each range and type
x.	Flow gauges excluding Rota meters	1 no. of each range and type
xi.	All types of Rota meters	1 no. of each range and type
Process Actuated Switch Devices-As applicable for this package, as per the following items.		
xii.	Temperature switches	1 no. of each range and type
xiii.	Pressure switches	1 no. of each range and type
xiv.	Differential Pressure switches	1 no. of each range and type
xv.	Level switches	1 no. of each range and type
xvi.	Flow switches	1 no. of each range and type
xvii.	Solenoid Valves	10 % or 1 no. of each type and model whichever is more
xviii.	Limit switches for pneumatic actuated valves	2 no. of each type
ANALYSERS As applicable for this package, as per the following items.		
xix.	PH Analyzer (a) Flow Through type cell and Electrode (b) Electronic Transmitter unity without sensor (c) Pre-fabricated cable with connector	 1 no of each type 1 no of each type 1 set
xx.	Turbidity Analyzer (a) Flow Through type cell and Electrode (b) Electronic Transmitter unity without sensor (c) Pre-fabricated cable with connector	1 no of each type 1 no of each type 1 set
xxi.	Any other online analyser other than those covered above (as applicable)	1 set
PROCESS CONNECTION PIPING (FOR IMPULSE PIPING/TUBING, SAMPLING PIPING/TUBING AND AIR SUPPLY PIPING AS APPLICABLE)		
xxii.	2 way, 3way, 5way valve manifolds	1 no. each of type, class, size and model
xxiii.	Filter regulator	1 no. of each type, class, size and model
CONTROL VALVES, ACTUATORS AND ACCESSORIES		
xxiv.	Control valve Smart Positioner Unit	1 No. of each type

NOTES:

The word 'TYPE' means the Make, Model no., Type, Range, Size/ Length, Rating, Material, accessories as applicable.

Wherever % age is identified, Vendor shall supply next higher rounded figure. Commissioning spares are part of Vendor scope of supply. Mandatory spares as indicated above do not cover commissioning spares.

Spares for Instruments shall be supplied alongwith the applicable accessories as mandatory spares. No accessories shall be supplied separately as mandatory spare.

19. COMMISSIONING SPARES

For successful pre-commissioning, commissioning and performance testing, requirements of
spares are to be provided by the contractor within quoted lump sum price and are to be listed in
the bid. Any additional spares used shall be to Contractor's account. Any kind of spares required for start-up and commissioning shall be provided.
In addition 2 number of Air Filter Regulator as the same make and model supplied for SVEBs/Pneumatic valves shall be supplied as mandatory spare.

20. QAP

Bidder shall furnish detailed Quality Assurance Program and Quality Plans for all materials and accessories to be supplied and installed under the scope of the specification. The Quality Plans shall include all tests/ checks as per relevant National/International Standards and the requirements of this specification including tests listed in this section. Refer the enclosed customer QAP(Annexure-2) for details.

21. SCHEDULES

21.1. Schedule of Technical Confirmations – Schedule-A

(Please indicate Yes / No)

1.	All the items / equipments / instruments as per Enquiry / PID are included in the scope	
2.	All the items / equipments / instruments are manufactured and tested as per relevant codes and standards.	
3.	All the items / equipment / instruments meet Enquiry technical BHEL specification	
4.	Erection of all supplied instruments and equipment included in scope	
5.	Laying & termination of cables included in scope	
6.	Laying & termination of impulse line for instruments included in scope	
7.	Laying & termination of copper tube for POV's included in scope	
8.	Pre commissioning checks will be included in scope	
9.	Commissioning included in the scope	
10.	Training at vendor's works and at site included in scope	
11.	Makes of all instruments and equipment will be as per the BHEL specification	
12.	Site specific Programming assistance for purchaser's PLC included in scope	
13.	Calibration at manufacturer's works included in scope	
14.	Calibration at site included in scope	
15.	Supply of commissioning spares included in scope	
16.	Supply of Tools & tackles included in scope	
17.	Supply of hand held programmer kit / calibrator suitable for all instruments included in scope	
18.	Supply of VFD panels included in scope	
19.	Supply of all calibration liquid, powder as per the BHEL specification included in scope.	
20.	In the event of order all drawings datasheets and documents as per the BHEL specification will be submitted to BHEL for approval.	
21.	All instruments / JB's/ SVEB's will be provided as per specification	
22.	Operation and maintenance manual in required numbers will be supplied for all items	
23.	Erection materials like Root valves, 3 way manifolds, impulse piping etc required for installing all instruments will be included in scope	
24.	Supply of cable trays, glands, lugs included in scope	
25.	Number of Digital inputs to be provided in PLC	Indicate quantity
26.	Number of Digital outputs to be provided in PLC	Indicate quantity

27.	Number of Analogue inputs to be provided in PLC	Indicate quantity
28.	Number of Analogue outputs to be provided in PLC	Indicate quantity
29.	Site support for auto operation through PLC as per Enquiry included in scope	
30.	Unit price for addition deletion as per Enquiry furnished in the Price Bid	

21.2. Schedule of Technical Deviations - SCHEDULE-B

Specn. Clause no.	Specification requirement	Bidder's deviation statement

It is certified that except the deviation listed above, all other tender clauses are complied with.

Signature of the Bidder

Date:

PART – B

SUB-SECTION – IIIB-01

MOTORS

CLAUSE NO.	TECHNICAL REQUIREMENTS

MOTORS

1.00.00 GENERAL REQUIREMENTS

1.01.00 For the purpose of design of equipment/systems, an ambient temperature of 50 deg. Centigrade and relative humidity of 95% (at 40 deg C) shall be considered. The equipment shall operate in a highly polluted environment.

1.02.00 All equipments shall be suitable for rated frequency of 50 Hz with a variation of +3% & -5%, and 10% combined variation of voltage and frequency unless specifically brought out in the specification.

1.03.00 Contractor shall provide fully compatible electrical system, equipments, accessories and services.

1.04.00 All the equipment, material and systems shall, in general, conform to the latest edition of relevant National and international Codes & Standards, especially the Indian Statutory Regulations.

1.05.00 Paint shade shall be as per RAL 5012 (Blue) for indoor and outdoor equipment.

1.06.00 The responsibility of coordination with electrical agencies and obtaining all necessary clearances for contractors equipment and systems shall be under the contractor scope.

1.07.00 Degree of Protection

Degree of protection for various enclosures as per IS:4691, IEC60034-05 shall be as follows :-

i)	Indoor motors	-	IP 54
ii)	Outdoor motors	-	IP 55
iii)	Cable box-indoor area	-	IP 54
iv)	Cable box-Outdoor area	-	IP 55

1.08.00 The voltage level for motors shall be as follows :-

Upto 0.2KW	:	240V, Single Phase AC/ 415V, Three Phase AC
Above 0.2 and upto 200 KW	:	415V, Three Phase AC
Above 200KW & upto 1500KW	:	3.3 kV, Three Phase AC
Above 1500kW	:	11 kV, Three Phase AC

Voltage ratings for all the submersible pump motors shall be on 415V only.

CLAUSE NO.	TECHNICAL REQUIREMENTS
2.00.00	**CODES AND STANDARDS** 1) Three phase induction motors : IS:325, IEC:60034 2) Single phase AC motors : IS:996, IEC:60034 3) Crane duty motors : IS:3177, IEC:60034 4) DC motors/generators : IS:4722, IEC:60034 5) Energy Efficient motors : IS 12615, IEC:60034-30
3.00.00	**TYPE**
3.01.00	**AC Motors:** a) Squirrel cage induction motor suitable for direct-on-line starting. b) Continuous duty LT motors upto 160 KW Output rating (at 50 deg.C ambient temperature), shall be **Premium Efficiency class-IE3**, conforming to IS 12615, or IEC:60034-30. c) Crane duty motors shall be slip ring/ squirrel cage Induction motor as per the requirement.
3.02.00	DC Motors Shunt wound.
4.00.00	**RATING** (a) Continuously rated (S1). However, crane motors shall be rated for S4 duty, 40% cyclic duration factor. (b) Whenever the basis for motor or driven equipment ratings are not specified in the corresponding mechanical specification sub-sections, maximum continuous motor ratings shall be at least 10% above the maximum load demand of the driven equipment under entire operating range including voltage and frequency variations. (c) For BFP motors starting MVA shall be restricted to 60 MVA.
5.00.00	**TEMPERATURE RISE** **Air cooled motors** 70 deg. C by resistance method for both thermal class 130(B) & 155(F) insulation. **Water cooled**

CLAUSE NO.	TECHNICAL REQUIREMENTS
	80 deg. C over inlet cooling water temperature mentioned elsewhere, by resistance method for both thermal class 130(B) & 155(F) insulation.
6.00.00	**OPERATIONAL REQUIREMENTS**
6.01.00	**Starting Time**
6.01.01	For motors with starting time upto 20 secs. at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at highest voltage limit shall be at least 2.5 secs. more than starting time.
6.01.02	For motors with starting time more than 20 secs. and upto 45 secs. at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at highest voltage limit shall be at least 5 secs. more than starting time.
6.01.03	For motors with starting time more than 45 secs. at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at highest voltage limit shall be more than starting time by at least 10% of the starting time.
6.01.04	Speed switches mounted on the motor shaft shall be provided in cases where above requirements are not met.
6.02.00	**Torque Requirements**
6.02.01	Accelerating torque at any speed with the lowest permissible starting voltage shall be at least 10% motor full load torque.
6.02.02	Pull out torque at rated voltage shall not be less than 205% of full load torque. It shall be 275% for crane duty motors.
6.03.00	**Starting voltage requirement** (a) Up to 85% of rated voltage for ratings below 110 KW (b) Up to 80% of rated voltage for ratings from 110 KW to 200 KW (c) Up to 85% of rated voltage for ratings from 201 KW to 1000 KW (d) Up to 80% of rated voltage for ratings from 1001 KW to 4000 KW (e) Up to 75 % of rated voltage for ratings above 4000KW Except AOP & JOP motors running on D.G emergency supply, starting voltage shall be 80%.
7.00.00	**DESIGN AND CONSTRUCTIONAL FEATURES**
7.01.00	Suitable single phase space heaters shall be provided on motors rated 30KW and above to maintain windings in dry condition when motor is standstill. Separate terminal box for space heaters & RTDs shall be provided. However for flame proof motors, space heater terminals inside the main terminal box may be acceptable.

CLAUSE NO.	TECHNICAL REQUIREMENTS
7.02.00	All motors shall be either Totally enclosed fan cooled (TEFC) or totally enclosed tube ventilated (TETV) or Closed air circuit air cooled (CACA) type. However, motors rated 3000KW or above can be Closed air circuit water cooled (CACW). CW motors can be screen protected drip proof (SPDP) type. Motors and EPB located in hazardous areas shall have flame proof enclosures conforming to IS:2148 as detailed below (a) Fuel oil area : Group – IIB (b) Hydrogen generation :Group - IIC or (Group-I, Div-II as per plant area NEC) or (Class-1, Group-B, Div-II as per NEMA /IEC60034)
7.03.00	Winding and Insulation (a) Type : Non-hygroscopic, oil resistant, flame resistant (b) Starting duty : Two hot starts in succession, with motor initially at normal running temperature. (c) 11kV & 3.3 kV AC motors : Thermal class 155 (F) insulation. The winding insulation process shall be total Vacuum Presure Impregnated i.e resin poor method. The lightning Impulse & interturn insulation surge withstand level shall be as per IEC-60034 part-15. (d) 240VAC, 415V AC & 220V DC motors : Thermal Class (B) or better
7.04.00	Motors rated above 1000KW shall have insulated bearings to prevent flow of shaft currents.
7.05.00	Motors with heat exchangers shall have dial type thermometer with adjustable alarm contacts to indicate inlet and outlet primary air temperature.
7.06.00	Noise level for all the motors shall be limited to 85dB(A) except for BFP motor for which the maximum limit shall be 90dB(A). Vibration shall be limited within the limits prescribed in IS:12075 / IEC 60034-14 . Motors shall withstand vibrations produced by driven equipment. HT motor bearing housings shall have flat surfaces, in both X and Y directions, suitable for mounting 80mmX80mm vibration pads.
7.07.00	In HT motors, at least four numbers simplex / two numbers duplex platinum resistance type temperature detectors shall be provided in each phase stator winding. Each bearing of HT motor shall be provided with dial type thermometer with adjustable alarm contact and preferably 2 numbers duplex platinum resistance type temperature detectors.

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7.08.00	Motor body shall have two earthing points on opposite sides.
7.09.00	11 KV motors shall be offered with Separate Insulated Connector (Elastimould or Equivalent make) as per IEEE 386. The offered elastimould terminations shall be provided with protective cover and trifurcating sleeves. Elastimould termination kit shall be suitable for fault level of 25 KA for 0.17 seconds.
7.10.00	3.3 KV motors shall be offered with dust tight phase separated double walled (metallic as well as insulated barrier) Terminal box. Suitable termination kit shall be provided for the offered Terminal box. The offered Terminal Box shall be suitable for fault level of 250 MVA for 0.12 sec. Removable gland plates of thickness 3 mm (hot/cold rolled sheet steel) or 4 mm (non magnetic material for single core cables) shall be provided.
7.11.00	The spacing between gland plate & centre of terminal stud shall be as per Table-I.
7.12.00	All motors shall be so designed that maximum inrush currents and locked rotor and pullout torque developed by them at extreme voltage and frequency variations do not endanger the motor and driven equipment.
7.13.00	The motors shall be suitable for bus transfer schemes provided on the 11kV, 3.3 kV /415V systems without any injurious effect on its life.
7.14.00	For motors rated 2000 KW & above, neutral current transformers of PS class shall be provided on each phase in a separate neutral terminal box.
7.15.00	The size and number of cables (for HT and LT motors) to be intimated to the successful bidder during detailed engineering and the contractor shall provide terminal box suitable for the same.
8.00.00	The ratio of locked rotor KVA at rated voltage to rated KW shall not exceed the following (without any further tolerance) except for BFP motor. (a) Below 110KW : 10.0 (b) From 110 KW & upto 200 KW : 9.0 (c) Above 200 KW & upto 1000KW : 10.0 (d) From 1001KW & upto 4000KW : 9.0 (e) Above 4000KW : 6 to 6.5
10.00.00	**TYPE TEST**
10.01.00	**HT MOTORS**
10.01.01	The contractor shall carry out the type tests as listed in this specification on the equipment to be supplied under this contract. The bidder shall indicate the charges for each of these type tests separately in the relevant schedule of Section - VII- (BPS) and the same shall be considered for the evaluation of the bids. The

CLAUSE NO.	TECHNICAL REQUIREMENTS
	type tests charges shall be paid only for the test(s) actually conducted successfully under this contract and upon certification by the employer's engineer.
10.01.02	The type tests shall be carried out in presence of the employer's representative, for which minimum 15 days notice shall be given by the contractor. The contractor shall obtain the employer's approval for the type test procedure before conducting the type test. The type test procedure shall clearly specify the test set–up, instruments to be used, procedure, acceptance norms, recording of different parameters, interval of recording, precautions to be taken etc. for the type test(s) to be carried out.
10.01.03	In case the contractor has conducted such specified type test(s) within last ten years as on the date of bid opening, he may submit during detailed engineering the type test reports to the employer for waival of conductance of such test(s). These reports should be for the tests conducted on the equipment similar to those proposed to be supplied under this contract and test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client. The employer reserves the right to waive conducting of any or all the specified type test(s) under this contract. In case type tests are waived, the type test charges shall not be payable to the contractor.
10.01.04	Further the Contractor shall only submit the reports of the type tests as listed in "LIST OF TESTS FOR WHICH REPORTS HAVE TO BE SUBMITTED "and carried out within last ten years from the date of bid opening. These reports should be for the test conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client. However if the contractor is not able to submit report of the type test(s) conducted within last ten years from the date of bid opening, or in the case of type test report(s) are not found to be meeting the specification requirements, the contractor shall conduct all such tests under this contract at no additional cost to the employer either at third party lab or in presence of client/ employer's representative and submit the reports for approval.
10.01.05	**LIST OF TYPE TESTS TO BE CONDUCTED** **The following type tests shall be conducted on each type and rating of HT motor** (a) No load saturation and loss curves upto approximately 115% of rated voltage (b) Measurement of noise at no load. (c) Momentary excess torque test (subject to test bed constraint). (d) Full load test (subject to test bed constraint) (e) Temperature rise test at rated conditions. During heat run test, bearing temp., winding temp.,coolant flow and its temp. shall also be measured. In

CLAUSE NO.	TECHNICAL REQUIREMENTS
	case the temperature rise test is carried at load other than rated load, specific approval for the test method and procedure is required to be obtained. Wherever ETD's are provided, the temperature shall be measured by ETD's also for the record purpose.
10.01.06	**LIST OF TESTS FOR WHICH REPORTS HAVE TO BE SUBMITTED** The following type test reports shall be submitted for each type and rating of HT motor (a) Degree of protection test for the enclosure followed by IR, HV and no load run test. (b) Terminal box-fault level withstand test for each type of terminal box of HT motors only. (c) Lightning Impulse withstand test on the sample coil shall be as per clause no. 4.3 IEC-60034, part-15 (d) Surge-withstand test on interturn insulation shall be as per clause no. 4.2 of IEC 60034, part-15
10.02.00	**LT Motors**
10.02.01	LT Motors supplied shall be of type tested design. During detailed engineering, the contractor shall submit for employer's approval the reports of all the type tests as listed in this specification and carried out within last *ten* years from the date of bid opening. These reports should be for the test conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client.
10.02.02	However if the contractor is not able to submit report of the type test(s) conducted within last ten years from the date of bid opening, or in the case of type test report(s) are not found to be meeting the specification requirements, the contractor shall conduct all such tests under this contract at no additional cost to the employer either at third party lab or in presence of client/ employer's representative and submit the reports for approval.
10.02.03	**LIST OF TESTS FOR WHICH REPORTS HAVE TO BE SUBMITTED** **The following type test reports shall be submitted for each type and rating of LT motor of above 50 KW only** 1. Measurement of resistance of windings of stator and wound rotor. 2. No load test at rated voltage to determine input current power and speed

CLAUSE NO.	TECHNICAL REQUIREMENTS
	3. Open circuit voltage ratio of wound rotor motors (in case of Slip ring motors) 4. Full load test to determine efficiency power factor and slip. 5. Temperature rise test. 6. Momentary excess torque test. 7. High voltage test. 8. Test for vibration severity of motor. 9. Test for noise levels of motor(Shall be limited as per clause no 7.06.00 of this section) 10. Test for degree of protection and 11. Overspeed test. 12. Type test reports for motors located in fuel oil area having flame proof enclosures as per IS 2148 / IEC 60079-1
10.03.00	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.
10.04.00	The type test reports once approved for any projects shall be treated as reference. For subsequent projects of NTPC, an endorsement sheet will be furnished by the manufacturer confirming similarity and “No design Change”. Minor changes if any shall be highlighted on the endorsement sheet.

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TABLE - I

DIMENSIONS OF TERMINAL BOXES FOR LV MOTORS

Motor MCR in KW of	**Minimum distance between centre stud and gland plate in mm**
UP to 3 KW	**As per manufacturer's practice.**
Above 3 KW - upto 7 KW	85
Above 7 KW - upto 13 KW	115
Above 13 KW - upto 24 KW	167
Above 24 KW - upto 37 KW	196
Above 37 KW - upto 55 KW	249
Above 55 KW - upto 90 KW	277
Above 90 KW - upto 125 KW	331
Above 125 KW-upto 200 KW	203

For HT motors the distance between gland plate and the terminal studs shall not be less than 500 mm.

PHASE TO PHASE/ PHASE TO EARTH AIR CLEARANCE:

NOTE: Minimum inter-phase and phase-earth air clearances for LT motors with lugs installed shall be as follows:

Motor MCR in KW	**Clearance**
UP to 110 KW	10mm
Above 110 KW and upto 150 KW	12.5mm
Above 150 KW	19mm

PART – B

SUB-SECTION – IIIC-01

BASIC DESIGN CRETERIA

CLAUSE NO.	TECHNICAL REQUIREMENTS
	BASIC DESIGN CRITERIA
1.00.00	**GENERAL REQUIREMENTS**
1.01.00	The Bidder shall provide Independent Control & Instrumentation system for control, monitoring and operation of associated drives and auxiliaries in all regimes of operation in safe and most efficient manner including Auxiliary Plant Control system associated Primary and Secondary Instruments, Panels / Desks. Process Connection and Piping, charges & batteries, associated Instrumentation Cables etc. as identified in the specification.
1.02.00	The Bidder shall provide all material, equipment and services so as to make a totally integrated Instrumentation and Control System together with all accessories, auxiliaries and associated equipment 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.
1.03.00	Further, Bidder shall also include in his proposal and 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 Bidder and for meeting the intent and requirements of the specification.
1.04.00	It is to be noted that where equipment or system for the generating units are described, it shall be understood that the quantities described are to be provided per unit basis, i.e., identical sets to be furnished by the Bidder for each of the units unless specifically indicated otherwise. Where equipment or systems for plant common facilities are described, it will be understood that the quantities described are the total quantities required. Wherever quantity has been specified as on as required basis, the same is to be supplied by the Bidder on as required basis by the Bidder within his quoted lump sum price.
1.05.00	Bidder shall include in his bid a detailed Bill of Material (BOM) for each of the systems.
1.06.00	In addition to requirements specified under this Section-VI, Part-B, all C&I systems/ sub-systems/ equipment/ devices shall also meet other requirements stipulated under other Sub-sections/ parts/ sections of specification.
2.00.00	**RELIABILITY AND AVAILABILITY**
2.01.00	Each component and system offered by the Bidder shall be of established reliability. The minimum target reliability of each piece of equipment like each electronic module/card, Power supply, Peripheral etc. shall be established by the Bidder, considering its failure rate/mean time between failures (MTBF), meantime to repair (MTTR), such that the availability of the complete C&I system is assured.
2.02.00	When more than one device uses the same measurement or control signal, the transmitter and other components/ module shall be fully equipped to provide all signal requirements. All the 4-20 mA output signals from transmitters/other control system shall be able to drive minimum 500 Ohms load resistance. The system shall be arranged so that the failure of any monitoring device or control components or

CLAUSE NO.	TECHNICAL REQUIREMENTS
	spurious intermediate grounding in the signal path shall not open the signal loop nor cause the loss or malfunction of signal to other devices using the same signal.
2.03.00	To ensure availability, adequate redundancy in system design shall be provided at hardware, software and sensor level to satisfy the availability criteria mentioned above. For the protection system, independent sensing device shall be provided to ensure adequate safety of plant equipment.
3.00.00	**OPERABILITY & MAINTAINABILITY**
3.01.00	The design of the control and instrumentation related equipment shall adhere to the principle of 'Fail Safe' Operation wherever safety of personnel / plant equipment is involved. 'Fail Safe' operation signifies that the loss of excitation or failure of any component shall not cause a hazardous condition. The types of failure that shall be taken into account for ensuring operability of the plant shall include but not be limited to: — Failure of sensor or transmitter. — Loss of motive power to final control element. — Loss of instrument air.
3.02.00	The choice of hardware shall also take into account sound maintainability principles and techniques. The same shall include but shall not be limited to the following: — Standardization of parts. — Minimum use of special tools. — Grouping of functions. — Interchangeability. — Malfunction identification facility/self surveillance facility. — Easy modular replacement. — Fool proof design providing proper identification and other features to preclude improper mounting and installation. — Appropriate de-rating of electronic components and parts.
3.02.00	The equipment shall employ latest state of the art technology to guard against obsolescence. In any case, Bidder shall be required to ensure supply of spare parts for lifetime of the plant. In case, the Bidder feels that certain equipment/component is likely to become obsolete, the Bidder shall clearly bring out the same in his Bid and indicate steps proposed to deal with such obsolescence.
4.00.00	**ENVIRONMENTAL CONDITIONS**
	Instruments, devices and equipment for location in outdoors/indoor/air-conditioned areas shall be designed to suit the environmental conditions indicated below and shall be suitable for continuous operation in the operating environment of a coal fired

CLAUSE NO.	TECHNICAL REQUIREMENTS

utility station and also during periods of air conditioning failure without any loss of function, or departure from the specification requirements covered under this specification.

Ambient Temperature (outside cabinets)	Pressure	Relative humidity	Atmosphere	Required protection Class of panels/ cabinets/ desks to be provided by Bidder.
Outdoor Location				
55 degree C max.	Atmosphere	100 % Max.	Air (dirty)	IP 55
4 degree C min.	Atmosphere	5 % min.	Air (dirty)	IP 55
Indoor Location				
55 degree C max.	Atmosphere	95 % Max.	Air	IP 54**
4 degree C min.	Atmosphere	5 % min.	Air	IP 54**
Air Conditioned Areas				
24 +/- 5 degree C normal	Atmosphere	95 % Max.	Air	IP 22***
50 degree C max.*	Atmosphere	5 %min.	Air	IP 22***

*** During air conditioning failure.**

****For non-ventilated enclosures. For ventilated enclosures, protection class shall be IP 42.**

*****With a suitable canopy at the top to prevent ingress of dripping water.**

For hazardous areas the protection class shall be in accordance with the requirements of the relevant NEC code for the location.

For PCs, OWS, EWS, Servers, Printers and other peripherals ,maximum temperature limit shall be 35 Deg. C. For LVS the same shall be 25 Deg C and for mini UPS, the same shall be 40 Deg. C max.

5.00.00 GROUNDING SYSTEM

All panels, desks, cabinets shall be provided with a continuous bare copper ground bus. The ground bus shall be bolted to the panel structure on bottom on both sides. The bolts shall face inside of panels.

The system ground shall be isolated from the panel ground with suitable isolators. All internal component grounds or common shall be connected to the system ground, which shall be fabricated of copper flat (size 25mm x 6mm min., length as applicable).

Shield on instrumentation cables shall be grounded on panel side. When shielding termination are required in cabinets furnished under this specification, suitable terminals shall be furnished on copper flat forming system ground. System and shield ground shall be connected to Owner provided earthing strip at 0.0 meter

CLAUSE NO.	TECHNICAL REQUIREMENTS
	level using suitable size of cable.In case same is not available,separate electronic earthpit shall be provided by the bidder. The Bidder shall submit with the offer recommended grounding scheme required for his system. The exact grounding scheme shall be finalised during detailed engineering.

PART – B

SUB-SECTION – IIIC-02

MEASURING INSTRUMENTS

CLAUSE NO.	TECHNICAL REQUIREMENTS
	MEASURING INSTRUMENTS
1.00.00	MEASURING INSTRUMENTS (PRIMARY AND SECONDARY)
1.01.00	Measuring instruments/equipment and subsystems offered by the Bidder shall be from reputed experienced manufacturers of specified type and range of equipment, whose guaranteed and trouble free operation has been proven. Refer Sub-section Basic Design Criteria. Further, all instruments shall be of proven reliability, accuracy, and repeatability requiring a minimum of maintenance. They shall comply with the acceptable international standards and shall be subject to Employer's approval. All instrumentation equipment and accessories under this specification shall be furnished as per technical specifications, ranges, makes/numbers as approved by the Employer during detailed engineering.
1.02.00	Every panel-mounted instrument requiring power supply shall be provided with a pair of easily replaceable glass cartridge fuses of suitable rating. Every instrument shall be provided with a grounding terminal and shall be suitably connected to the panel grounding bus.
1.03.00	All local gauges as well as transmitters, sensors, and switches for parameters like pressure, temperature, level, flow etc. as required for the safe and efficient operation and maintenance as well as for operator and management information (including all computation) of equipment under the scope of specification shall be provided on as required basis within the quoted lump sum price. For bidding purpose, tentative minimum instruments have been indicated on the P&IDs. However, contractor shall supply any additional local gauges /switches /transmitters / sensors for reasons mentioned above without any additional cost to the Employer.
1.04.00	The necessary root valves, impulse piping, drain cocks, gauge-zeroing cocks, valve manifolds and all the other accessories required for mounting/erection of these local instruments shall be furnished, even if not specifically asked for, on as required basis. The contacts of equipment mounted instruments, sensors, switches etc. for external connection including spare contacts shall be wired out in flexible/rigid conduits, independently to suitably located common junction boxes. The proposal shall include the necessary cables, flexible conduits and accessories for the above purpose. Double root valves shall be provided for all pressure tapping where the pressure exceeds 40 Kg./sq.cm.
1.05.00	For sea water applications, all instruments applications, they shall be provided with wetted parts made of Monel/ Hastelloy C or any other material (if proven ness experience of the proposed material for such applications is established by contractor)

<table>
<tr><th>CLAUSE NO.</th><th>TECHNICAL REQUIREMENTS</th></tr>
<tr><td>1.06.00</td><td>For coastal areas, all instruments shall be provided with durable epoxy coating for housings and all exposed surfaces of the instruments.</td></tr>
<tr><td>2.01.00</td><td>Specification for Electronic Transmitters for Press, Diff Press, DP based Flow, Level measurement.
<table>
<tr><th>Sr.No</th><th>Features</th><th></th><th>Essential/Minimum Requirements</th></tr>
<tr><td>1.</td><td>Type of Transmitter</td><td>:</td><td>Microprocessor based 2 wire type (loop powered), HART protocol compatible.</td></tr>
<tr><td>2.</td><td>Accuracy</td><td>:</td><td>± 0.1% of calibrated span (minimum)</td></tr>
<tr><td>3.</td><td>Output signal</td><td>:</td><td>4-20 mA DC (Analog) along with superimposed digital signal (based on HART protocol)</td></tr>
<tr><td>4.</td><td>Turn down ratio</td><td>:</td><td>10:1 for vacuum/very low pressure applications(i.e<=200mmwc).
30:1 for other applications.</td></tr>
<tr><td>5.</td><td>Stability</td><td>:</td><td>± 0.1% of calibrated span for six months for Ranges up to and including 70 Kg/cm² (g).
± 0.25% of calibrated span for six months for Ranges more than 70 Kg/cm² (g).</td></tr>
<tr><td>6.</td><td>Zero and span drift</td><td>:</td><td>+/- 0.015% per deg.C at max span.
+/-0.11% per deg.C at min. span.</td></tr>
<tr><td>7.</td><td>Load impedance</td><td>:</td><td>500 ohm (min.)</td></tr>
<tr><td>8.</td><td>Housing</td><td>:</td><td>Weather proof as per IP-65, metallic housing with durable corrosion resistant coating.</td></tr>
<tr><td>9.</td><td>Over Pressure</td><td>:</td><td>150% of max. Operating pressure.</td></tr>
<tr><td>10.</td><td>Electrical connection</td><td>:</td><td>Plug and socket type.</td></tr>
<tr><td>11.</td><td>Process connection</td><td>:</td><td>1/2 inch NPT (F)</td></tr>
<tr><td>12.</td><td>Span and Zero adjustment</td><td>:</td><td>Continuous, tamper proof, Remote as well as manual adjustability from instrument with zero suppression and elevation facility.</td></tr>
<tr><td>13.</td><td>Accessories</td><td>:</td><td>-Diaphragm seal, pulsation dampeners, syphon etc. as required by service and operating condition.
-2 valve manifold for absolute & Gauge pressure transmitters, 3-valve manifold for vacuum</td></tr>
</table></td></tr>
</table>

CLAUSE NO.	TECHNICAL REQUIREMENTS

			pressure transmitters & where DP transmitters are being used for pressure measurement and 5 valve manifolds for DP/Level/Flow application. -For hazardous area, explosions proof enclosure as described in NEC article 500.
14.	Diagnostics & display	:	Self Indicating feature and digital display on transmitter
15.	Power supply	:	24V DC ± 10%.
16.	Adjustment/calibration/ maintenance	:	Using hand held HART calibrator.

Notes

1) LVDT type is not acceptable.

2) Where the process fluids are corrosive, viscous, solid bearing or slurry type, diaphragm seals shall be provided. Parts below the diaphragm shall be removable for cleaning. The entire volume above the diaphragm shall be completely filled with an inert liquid suitable for the application.

2.02.00 SPECIFICATION FOR ELECTRO-MAGNETIC TYPE FLOW TRANSMITTER

S.No.	Features	Essential/Minimum requirement
1.	Type of Transmitter	Microprocessor based 2 wire type, HART protocol compatible, full bore type.
2.	Output signal	4-20 mA DC (Analog) along with superimposed digital signal (based on HART protocol).
3.	Accuracy	+/- 0.5% of calibrated span.
4.	Power supply	24 V DC +/- 10%.
5.	Housing	Weather proof as per IP-65, metallic housing with durable corrosion resistance coating.
6.	Adjustment/calibration/	Using hand held HART calibrator.

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	maintenance	
7.	Zero and Span adjustment	Continuous, tamper proof, remote as well as manual adjustability from instrument. It should be possible to calibrate the instrument without any process flow.
8.	Sensor Material	Corrosion resistant material to suit individual application requirement.
9.	Flow tube	SS304.
10.	Liner	Hard rubber or better material to suit the actual application.
11.	Range	Should be suitable for the required process range.
12.	Display	Integral digital display
13.	Load Impedance	500 ohms (minimum).
14.	Accessories	• All weather canopy shall be provided for protection from direct sunlight and direct rain for open locations. • All mounting accessories required for erection and commissioning shall be provided. • For hazardous area, explosion proof enclosure as described in NEC article 500

Note:-

Four wire type transmitters can also be provided for applications where 2-wire transmitter has some technical limitations, subject to employer's approval during detailed engineering stage. However, in such cases isolated

CLAUSE NO.	TECHNICAL REQUIREMENTS

4-20 mA DC (analog) output shall be provided. Power supply required for such transmitters shall be 240V AC / 24V DC.

2.03.00 Specification for ULTRASONIC TYPE FLOW TRANSMITTER

S.No.	Features	Essential/Minimum requirement
1.	Type of Transmitter	Non contact Microprocessor based 2 wire type, HART protocol compatible Ultrasonic transmitter. Insertion type.
2.	Output signal	4-20 mA DC (Analog) along with superimposed digital signal (based on HART protocol).
3.	Sensor Accuracy	+/- 2% of calibrated span.
4.	Sensor Repeatability	NA
5.	Power supply	24 V DC +/-10%.
6.	Temperature compensation	To be provided within transducer.
7.	Configuration	
8.	Housing	Weather proof as per IP--65 , metallic housing with durable corrosion resistance coating.
9.	Adjustment/calibration/ maintenance	Using hand held calibrators.
10.	Zero and Span adjustment	Continuous, tamper proof, remote as well as manual to calibrate the instrument without any process flow.
11.	Sensor Material	Corrosion resistant material to suit individual application requirement.
12.	False signal tolerance	Transmitter shall e capable of ignoring false echoes from internal tank/sumps obstructions such as pipes, heating coils or agitator blades. Also transmitter shall have adjustable damping circuitry.
13.	Range	Should be suitable for the required process range.

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14.	Display	LCD display with integral keypad to be provided.
15.	Diagnostics	Loss of echo alarm etc.
16.	Load Impedance	500 ohms minimum
17.	Electrical Connection	Plug and socket
18.	Accessories	• All weather canopy for protection from direct sunlight and direct rain. • All mounting hardware and accessories required for erection and commissioning mounting fittings materials shall be SS 316. • For hazardous area, explosion proof enclosure as described in NEC article 500

2.04.00 **Specification for TEMPERATURE TRANSMITTER**

Following type of 2-wire(loop powered) temperature transmitter (directly powered from 4-20mA input cards of DDCMIS/PLC) shall be provided. The temperature transmitter shall be fully compatible with thermocouples and RTDs being provided by the contractor. Temperature compensation of the thermocouples shall be performed in the temperature transmitter itself.

a). **Single Input Head mounted Temperature Transmitter**

These shall be suitable for mounting in the head of temperature element itself.

b) Single Input DIN-rail mounted Temperature Transmitter

These shall be suitable for mounting on DIN-rails in JBs. The specifications of the JBs shall be same as indicated in Subsection INST CABLE with additional DIN-rails and IP 65 Protection class. This temperature transmitter shall be the ones which are especially designed for DIN-rail mounting with IP 20 protection class. These shall have terminals for input/output provided on front side when mounted on DIN-rail. Head mounted temperature transmitter with clamps to make it suitable

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for DIN-rail mounting shall not be acceptable under this category.

Requirements for each of the above type of temperature transmitters

Output	:	2-wire (power supply from input card of Control System) with 4-20mA output with superimposed HART protocol signal.
Input	:	Same transmitter shall be capable to handle Pt-100 RTD , Thermocouples –K&R types (input type to be selectable at site through HART terminal)
Isolation	:	min. 500 V AC
EMC compatibility	:	as per EN 61326
Operating ambient temperature	:	0 to 85 deg C (without indicator) 0 to 70 deg C (with indicator)
Power supply		24V DC +/- 10%.
Accessories		Mounting arrangements including clamps etc.
Composite Accuracy		

RTD	=<0.4% of 0-250 deg C span
T/C-K type	=<0.4% of 0-600 deg C span
T/C-R type	=<0.4% of 0-1000 deg C span

CJC accuracy (for thermocouples) shall be =< 1 deg C

Notes:-

1. In case of failure (open or burn-out) of RTD/thermocouple, temp. Transmitter shall provide low temperature output.
2. Composite Accuracy is to be calculated as summation of all applicable accuracies of temp transmitter, for converting sensor input to output in 4-20 mA (e.g., basic accuracy, digital accuracy, D/A accuracy, etc.) and temperature effect on these accuracies at ambient temperature of 50 deg C, based on the figure/ formula given in the standard product catalogue for span as specified above for various types of Temperature Elements specified. All such accuracy/ temp effect figures in catalogue shall be first converted to deg C, and then percentage of this converted accuracy in specified span shall be calculated to compare with the specified composite accuracy figures.

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2.05.00 **Specification for TEMP ELEMENTS**

2.05.01 **Specification for Resistance Temperature Detector (RTD)**

Sr. No.	Features		Essential/Minimum Requirements
1	Type of RTD.	:	Pt-100 (100 Ohms resistance at zero degree Centigrade).
2	No. of element	:	Duplex
3	Housing/Head	:	IP-65/Diecast Aluminum. Head of TE to be provided with sufficient space and arrangement to mount head mounted temperature transmitter (as applicable).Plug in connector for external signal cable connection shall be provided. TE terminal head shall be spring loaded for positive contacts with the thermo well..
4	Insulation and Sheathing of RTD	:	Mineral (magnesium oxide) insulation and SS316 sheath, ceramic packed.
5	Calibration and accuracy	:	As per IEC-751/ DIN-43760 Class-A for RTD
6	Characteristic	:	Linear with respect to temp, within ±1/2 of top range value
7	Accessories	:	Thermo well (as specified below) and shall be spring loaded for positive contacts with the well.
8	Standard	:	IEC-751/ DIN-43760 for RTD and ASME PTC-19.3 for thermo well.

NOTES :

1) The specifications for RTDs of winding/ bearings of motor/pump, can be as per their manufacturer standards. The manufacturer shall submit the adequate supporting documents for establishing their standard practice. However the type of RTD shall be Pt100.

2) The specifications of temp elements for air conditioning & ventilation system / process can be as per system manufacturer's standards. The manufacturer shall submit the adequate supporting documents for establishing their standard practice.

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2.05.02 **Specification for Thermocouples**

Sr.No	Features		Essential/Minimum Requirements
1	Type of Thermocouple.	:	16 AWG wire of Chromel-Alumel (Type K) or 24 AWG wire Pt-Rhodium Pt (Type R) depending on operating temperature Range (ungrounded separate junction type).
2	No. of element	:	Duplex
3	Housing/Head	:	IP-65/Diecast Aluminium. Head of TE to be provided with sufficient space and arrangement to mount head mounted temperature transmitter (as applicable). Plug in connectors are to be provided for external signal cable connection. TE terminal head shall be spring loaded for positive contacts with the thermo well.
4	Insulation and Sheathing of Thermocouple	:	Swaged type mineral (magnesium oxide) insulation and SS316 sheath.
5	Calibration and accuracy	:	As per IEC-584/ANSI-MC-96.1(special limits of errors/ class1) for T/C.
6	Characteristic	:	Linear with respect to temp, within ±1/2 percent of top range value.
7	Accessories	:	Thermo well (as specified below)
8	Standard	:	IEC-584/ ANSI MC 96.1 for Thermocouple and ASME PTC-19.3 for Thermo-well.

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Notes :

1) The specifications for thermocouples of bearings metal temp measurements can be as per their manufacturer standards. The manufacturer shall submit the adequate supporting documents for establishing their standard practice However type of thermocouples shall be K type.

2.05.03 **Specification for Thermo well**

Thermo well shall be one piece solid bored type of 316 SS of step-less tapered design, (As per ASME PTC 19.3 1974).

CLAUSE NO.	TECHNICAL REQUIREMENTS

3.00.00 Hand held calibrator

The hand held type universal calibrator shall be provided for adjustment/calibration/maintenance of the HART compatible transmitters. The hand held calibrator shall be suitable for all types of transmitters supplied in the package. If one type of hand held type calibrator is not suitable for communicating with all types of transmitters then separate hand held calibrator will be provided for that specific type of transmitter.

4.00.00 Specification for Press Gauge, DP Gauge, Temp Gauge, Level Gauge

	FEATURES	**ESSENTIAL/ MINIMUM REQUIREMENTS**		
		Pr. Gauge/ DP Gauge/ Draught gauges	**Temperature Gauge**	**Level Gauge**
1	Sensing Element	Bourdon for high pressure measurement, Diaphragm/ Bellow for low press measurement.	Mercury in steel / inert gas actuated.	Tempered * toughened Borosilicate gauge glass , steel armoured reflex or transparent type.
2	Body material	Die-cast aluminum.	Die-cast aluminum.	Forged carbon steel/ 304 SS.
3	Dial size	150 mm.	150 mm	Tubular covering Process connection± 2%
4	End connection.	1/2 inch NPT (F) as per ASME PTC.	3/4" NPT (F).	
5	Accuracy	±1% of span	± 1% of span	
6	Scale	Linear, 270° arc graduated in metric units.	Linear, 270° arc graduated in °C.	Linear vertical
7	Range	Cover 125% of max.	Cover 125% of	Cover 125% of

CLAUSE NO.	TECHNICAL REQUIREMENTS

	selection	of scale	max. of scale	max. of scale
8	Over range test	Test pr. for the assembly shall be1.5 to the Design press at 38°C		
9	Housing	Weather and dust proof as per IP-55.	Weather and dust proof as per IP-55.	CS/ 304 SS leak proof.
10	Zero/span adjustment	Provided	Provided	—
11	Identification	Suitable metal service tag shall be provided.		
12	Accessories	Blow out disc, siphon, snubber, pulsation dampener, chemical seal(if required by process) gauge isolation valve.	SS Thermo well	Gasket for all KEL-F shields for transparent type. Vent and drain valves of Steel/ SS as per CS/ Alloy process Requirement. For acid / alkali applications material of drain and vent valves shall be as suitable for these mediums.
13	Material of sensor/ movement	316 SS / 304 SS	316 SS / 304 SS	

Notes:-

1) *Bicolour type level gauges will be provided for applications involving steam and water except for condensate and feed water services.

Length of gauge glass shall not be more than 1400 mm. If the vessel is higher, multiple gauge glasses with 50 mm overlapping shall be provided.

2) Where the process fluids are corrosive, viscous, solid bearing or slurry type, diaphragm seals shall be provided. Parts below the diaphragm shall be removable

CLAUSE NO.	TECHNICAL REQUIREMENTS

for cleaning. The entire volume above the diaphragm shall be completely filled with an inert liquid suitable for the application.

3) Pressure/ Diff pressure gauges for very low press/ DP measurements can have sensor material other than SS316 e.g. silicon etc., if the offered material is suitable for that application and the offered product is standard product of the manufacture for very low pressure applications.

4) The specifications for gauges which are integral part of motor bearings can be as per their manufacturer standards.

5.00.00 ROTAMETER

Sr. No.	Features		Essential / minimum requirements
1.	Type		Variable area metal tube type.
2.	Fluid media		Water/oil
3.	Tube body		SS 316
4.	Material of float		316 SS
5.	Indicator		Linear scale.
6.	Accessories		Flange, orifice in case of bypass Rota meter (for line size above ~~50~~ 100 mm).
7.	Housing protection class		IP-55
8.	Accuracy		+/- 2% of full range

6.00.00 SPECIFICATION OF ANALYSERS

6.00.01 Common Requirements

1.	Type of electronics	Microprocessor based
2.	Zero & span Adjustment	To be provided
3.	Ambient temp.	50°C
4.	Display	LCD
5.	Enclosure Type / Material	Weather and Dust proof (IP 55), Die cast aluminum with corrosion resistant epoxy coating for external field mounting analysers
6.	Output signals Analog	4-20 mA DC
7.	Error / fault Diagnostic	To be provided.
8.	Power supply	For power supply and distribution, refer scope / and terminal point part of the specification. Conversion / distribution from the terminal point shall be done by contractor. The power supply to all the analyzers / monitors shall be supplied by

CLAUSE NO.	TECHNICAL REQUIREMENTS	
		contractor with all necessary switches, fuses, wiring / cabling and other required accessories etc. for distribution to individual requirements.
	9. Load	500 Ohms minimum
	10. Mounting	All mounting arrangements for the sensors and the monitors are to be provided by the Contractor. SWAS instruments to be mounted in the panel except Hotwell analysers. For the same and other field application free standing cabinet(s) / panel / rack is to be provided by the Contractor for mounting the analysers / transmitters / meters as applicable due to environment.
	11. Other Requirements	All chemical reagents required for silica, phosphate, sodium, chloride, residual chlorine and hydrazine analyzers for 12 months operation is to be supplied in phased manner depending on shelf life.
6.01.00	**Conductivity Analyser**	
	a) Type	For Hot well: Removable (Direct insertion / withdrawal) type of cells. For others: Continuous flow through type
	b) Range	**:** For SWAS analysers, 0-1, 0-10, 0-100 micro mho/cm freely programmable for specific conductivity. 0-1 micro mho/cm log scale for Cation conductivity **:** For others 0-1, 0-10, 0-100, 0- 1000, 0- 10,000 micro mho/cm freely programmable. : 0-2500 ppm for Total Dissolved Solids (TDS).
	c) Accuracy	**:** <=+/- 1 % of reading
	d) Temperature Compensation	**:** Automatic

CLAUSE NO.	TECHNICAL REQUIREMENTS
	e) Response time : <=5 sec. **f) No. of Streams** : Single **g) Other** : Wherever cation conductivity measurement have been specified dual cation exchange column shall be provided.
6.02.00	**pH Analyser** **a) Type** : Cell - flow through **b) Accuracy** : < ± 1% of reading **c) Range** : 6-11 pH freely programmable (For SWAS area) 0 - 14 pH freely programmable (For others) **d) No. of steams** : Single **e) Temp. compensation** : Automatic
6.03.00	**Turbidity Analyser** **a) Type** : Light reflection principle **b) Range** : 0-100, 0-200 NTU programmable **c) Accuracy** : <= 2% for range 0 – 50 NTU <= 5% for range 50 - 200 NTU **d) Response time (90 % of full scale)** : <= 5 minutes. **e) No. of steams** : Single
6.04.00	Residual Chlorine Analyser The analyser shall comply with the following specification requirements, as a minimum **a) Service** : Chlorination Plant **b) Type** : Amperometric type **c) Range** : 0 to 20.0 mg/L (ppm) **d) Accuracy** : <=+/- 5 % (see Note – 1)

CLAUSE NO.	TECHNICAL REQUIREMENTS

	e) Alarm annunciation	:	High and low alarms to be provided on panel and shall be field adjustable.
	f) Calibration	:	Zero and span adjustment facility to be provided. Final calibration adjustments of the analyser to be done at site and duly verified by titration. Temperature compensation range 0 to 50 deg.C.
	g) Connections	:	All connections for sampling drain etc. to be provided.
	h) Cabling	:	All field cabling power cables and panel wiring etc., to be provided.
	i) Electrodes	:	Platinum/Gold and copper electrodes shall be provided with cell cleaning system.

Note-1: The measurement accuracy shall not be affected by presence of treatment chemicals as chromates, phosphates, de-former highly polluted water, change in temperature etc.

Note-2: Circulating water as sample to residual chlorine analyser shall be taken from hot circulating water pipe work before entry to cooling towers. Exact location and layout of sampling arrangement shall be finalized during detailed Engg. stage. Bidder shall provide necessary pumping system (with 100% standby) for meeting the analyser requirements, if needed. All the drains shall be terminated up to the nearest Employer's plant drainage system.

7.00.00 **SPECIFICATION FOR FLOW ELEMENTS**

7.01.00 Orifice Plate

Essential / Minimum Requirements are:

Type	Concentric as per ASME PTC-19.5 (Part-II), ISA RP-3.2, 1960 or BS-1042 or ISO 5167
Material	316 SS
Thickness	3 mm for main pipe diameter up to 300 mm and 6 mm for main pipe diameter above 300 mm.
Material of branch pipe	Same as main pipe
Root valve type	Globe

CLAUSE NO.	TECHNICAL REQUIREMENTS	
	Root valve material	316 SS
	Root valve size	**1 / 2 inch or 1 inch (as applicable)**
	Impulse pipe of same material up to root valve	Required
	Tappings	**Flanged weld neck or D & D/2 with 3 pairs of tapping (as applicable). Root valves to be provided in all the tappings.**
	Beta Ratio	Around 0.7
	Beta Ratio calculation to be submitted	Yes
	Assembly drg. and flow Vs DP Curves	Yes
	Accessories	Root valves, flanges, Vent/drain hole (As applicable)
	Note: Contractor shall submit certified flow calculation and differential pressure v.s. flow curves for each element for Employer's approval. Sizing calculation, precise flow calculation for all the flow elements, fabrication and assembly drawings and installation drawings shall be submitted for Employer's approval.	
7.02.00	**Flow Nozzle**	
	Essential / Minimum Requirements are:	
	Type	Long radius, welded type as per ASME PTC-19.5 (Part-III) or BS-1042 or ISO 5167
	Material	316 SS
	Thickness	Suitable for intended application
	Material of branch pipe	Same as main pipe
	Root valve type	Globe
	Root valve material	316 SS
	Root valve size	**1 / 2 inch or 1 inch (as applicable)**
	Impulse pipe of same material up to root valve	Required

CLAUSE NO.	TECHNICAL REQUIREMENTS

	Tappings	**Flanged weld neck or D & D/2 with 3 pairs of tapping (as applicable). Root valves to be provided in all the tappings.**
	Beta Ratio	Around 0.7
	Beta Ratio calculation to be submitted	Yes
	Assembly drg. and flow Vs DP Curves	Yes
	Accessories	Root valves, flanges, Vent/drain hole (As applicable)

Note: Contractor shall submit certified flow calculation and differential pressure v.s. flow curves for each element for Employer's approval. Sizing calculation, precise flow calculation for all the flow elements, fabrication and assembly drawings and installation drawings shall be submitted for Employer's approval.

8.00.00 **SOLENOID VALVES**

Solenoid valves shall fulfil the following requirements :

a. Type 2/3/4 way SS 316/Forged Brass (depending on the application subject to Employer’s approval during detailed Engg.)

b. Power supply 24 V DC ± 10%.

c. Plug and socket electrical connection.

d. Insulation : Class ‘H’

PART – B

SUB-SECTION – IIIC-03

PROCESS CONNECTION & PIPING

CLAUSE NO.	TECHNICAL REQUIREMENTS
	PROCESS CONNECTION AND PIPING
1.00.00	**PROCESS CONNECTION PIPING**
1.01.00	The Contractor shall provide, install and test all required material for completeness of Impulse Piping System and Air Piping System as per the requirements of this Sub-section enclosed installation drawings and source connection drawings on as required basis for the connection of instruments and control equipment to the process and make the system complete. The Contractor shall furnish during detailed engg. all relevant drawings, material and tech. specifications of various items service wise for Employer's approval.
1.01.01	All materials supplied under this Sub-section shall be suitable for intended service, process, operating conditions and type of instruments used and shall fully conform to the requirements of this specification. The material offered by the Bidder shall be from reputed, experienced manufacturer whose guaranteed and trouble free operation has been proven at least for two years in not less than two pulverised coal fired utility stations.
1.02.00	IMPULSE PIPING, TUBING, FITTINGS, VALVES AND VALVE MANIFOLDS
1.02.01	All impulse pipe shall be of seamless type conforming to ANSI B36.10 for schedule numbers, sizes and dimensions etc. The material of the impulse pipe shall be same as that of main process pipe. For protection against sea environment,all impulse pipes,fittings etc.shall be provided with durable epoxy coating with poly urethane furnish.
1.02.02	All fittings shall be forged steel and shall conform to ANSI B16.11. . The material of forged tube fittings for shaped application (e.g. Tee, elbow etc.) shall be ASTMA 182 Gr. 316 H for high pressure/ temperature applications (as defined above) and ASTMA 182 Gr. 316L for other applications. The material for bar stock tube fitting (for straight application) shall be 316 SS. Metal thickness in the fittings shall be adequate to provide actual bursting strength equal to or greater than those of the impulse pipe or SS tube, with which they are to be used.
1.02.03	The source shut-off (primary process root valve) and blow down valve shall be of 1/2 inch size globe valve type for all applications except for air and flue gas service wherein no source shut-off valves are to be provided.The disc and seat ring materials of carbon steel and alloy steel valves be ASTM A-105 and ASTM A-182, Gr. F22, hard faced with stellite (minimum hardness - 350 BHN.) The surface finish of 16 RMS or greater is required in the area of stem packing. The valve design shall be such that the seats can be reconditioned and stem and disc may be replaced without removing the valve body from the line.
1.02.04	The valve manifolds shall be of 316 stainless steel with pressure rating suitable for intended application. 2 valve manifold and 3-valve manifold shall be used for pressure measurements using pressure transmitters/ pressure switches and diff. pressure transmitter/ switches respectively. 5-valve manifold shall be used for remaining applications like DP, flow and level measurements.
1.02.05	For Pr./D.P gauges in fluid application two-way globe valve on each impulse line to the instrument and in A/F application two-way gate valve on each impulse line to the

CLAUSE NO.	TECHNICAL REQUIREMENTS
	instrument shall be provided near the instrument. These shall be in addition to the three ways gauge cock provided alongwith the pr./D.P gauges.
2.00.00	**AIR SUPPLY PIPING**
2.01.00	All pneumatic piping, fittings, valves, air filter cum regulator and other accessories required for instrument air for the various pneumatic devices/ instruments shall be provided.
2.01.01	This will include as a minimum air supply to pneumatically operated control valves, actuators, instruments, continuous and intermittent purging requirements of etc.
2.02.00	For individual supply line and control signal line to control valve, 1/4-inch size light drawn tempered copper tubing conforming to ASTM B75 shall be used. The thickness of cu-tubing shall not be less than 0.065 inch and shall be PVC coated. The fittings to be used with copper tubes shall be of cast brass, screwed type.
2.03.00	All other air supply lines of 1/2 inch to 2 inch shall be of mild steel hot dipped galvanized inside and outside as per IS-1239, heavy duty with threaded ends. The threads shall be as per ASA B.2.1. Fittings material shall be of forged carbon steel A234 Gr. WPB galvanized inside and outside, screwed as per ASA B2.1. Dimensions of fittings shall be as per ASA B16.11 of rating 3000 lbs.
2.04.00	All instrument air filters cum regulator set with mounting accessories shall be provided for each pneumatic device requiring air supply. The filter regulators shall be suitable for 10-kg/ sq.cm max. Inlet pressure. The filter shall be of size 5 microns and of material sintered bronze. The air set shall have 2-inch size pressure gauge and built in filter housing blowdown valve. The end connection shall be as per the requirement to be finalised during detailed engineering.
2.05.00	All the isolation valves in the air supply line shall be gate valves as per ASTM B62 inside screw rising stem, screwed female ends as per ASA B2.1. Valve bonnet shall be union type & trim material shall be stainless steel, body rating 150 pounds ASA. The valve sizes shall be ½ inch to 2 inch.
3.00.00	**SAMPLE PIPING SYSTEM**
3.01.00	This shall include piping, fittings, valves and accessories from tapping points upto Contractor's conditioning panel/sample coolers and/or Analysers. All sample piping shall be 3/4" NB seamless type of material ASTM A213 TP 316 H, conforming to ANSI B36.19. The schedule number shall be suitable for the particular application.
3.02.00	All fittings shall be socket welding type and of material ASTMA182 F316H conforming to ANSI B 16.11.
3.03.00	Single and multi tubes shall run with the minimum number of changes in direction. Suitable identification tags shall be provided for easy check up and for proper connections.

CLAUSE NO.	TECHNICAL REQUIREMENTS
3.04.00	The valves to be used in sample piping shall be of globe type, forged construction and stainless steel conforming to ASTM A182. The pressure temperature ratings shall be as per ANSI B16.34. The valve design shall be such that the seats can be reconditioned and stem and disc can be replaced without removing valve body from the line.
4.00.00	**INSTALLATION AND ROUTING**
4.01.00	Instrument Piping System
4.01.01	For steam and liquid measurements, the impulse pipe should preferably slope downward from source connection to instrument and instrument shall be installed below the source point. If due to any reason instrument is installed above the source point, the impulse pipe should slope upwards continuously and a 'pigtail' should be provided at the instrument to assure water seal for temperature protection. For vacuum measurements instrument shall be installed above source point and impulse pipe should slope upwards.
4.01.02	Impulse piping for air and flue gas shall slope upwards and instrument shall be installed above source point. If this requirement cannot be met special venting or drain provision shall be provided with vent & drain lines alongwith isolation valves and other accessories including drainpipes. This drain is to be connected to plant drain through open funnel also.
4.01.03	All impulse piping shall be installed to permit free movement due to thermal expansion. Wherever required expansion loops shall be provided.
4.01.04	Special accessories such as condensing pots/ reservoirs shall be provided and installed wherever required. In any case condensing pots shall be provided for all level measurements in steam and water services, all flow measurement in steam services and flow measurements water services above 120 Deg. C.
4.01.05	Colour coding of all impulse pipes shall be done by the bidder in line with the colour coding being followed for the parent pipes.
4.02.00	Instrument Air & Service Air Piping/ Tubing System
4.02.01	Instrument air & service air headers and their branches with all associated fittings & accessories shall be provided for giving supply to all consumers, as per the requirements. Air piping shall be installed always with a slope of over 1/20 to prevent accumulation of water within the pipe.
4.02.02	Single and multi tubes shall run with the minimum number of changes in direction. Suitable identification tags shall be provided for easy checkup and for connections.
5.00.00	**PIPING/TUBING SUPPORT**
5.01.00	Impulse piping and sample piping shall be supported at an interval not exceeding 1.5 meters. Each pipe shall be supported individually using slotted angle mounted clamps with necessary fixtures. Tubing shall run in proper perforated trays with proper cover. Tubing shall be supported inside the trays by aluminium supports. Hangers and other fixtures required for support of piping and trays shall be provided, either by welding or by bolting on walls, ceilings and structures. Hanger clamps and

CLAUSE NO.	TECHNICAL REQUIREMENTS
	other fastening hardware shall be of corrosion resistant metals and hot-dip galvanized.
6.00.00	**SHOP AND SITE TESTS**
6.01.00	General Requirements
6.01.01	The equipment and work performed as per this Sub-section shall be subject to shop and site test as per requirements of Sub-section-Q (Quality Assurance & Inspection) other applicable clauses of this Sub-section and Employer approved quality assurance plan.
6.01.02	Hydrostatic and pneumatic tests shall be performed on all pipes, tubing and systems and shall conform to ANSI B31.1.
6.02.00	Hydrostatic Testing
6.02.01	All instrument piping/ tubing shall be hydrostatically tested upon completion of erection. The test pressure shall be 1.5 times the maximum process pressure. The test shall be performed either with the testing of associated process piping or without the associated process piping (by closing the root valve). In both the cases the instrument shall be isolated by closing the shut-off valve.
6.03.00	Air Testing
6.03.01	All air headers & branch pipes shall be air tested by pressure decay method as per ANSI B31.1. Flexible hoses and short signal tubing shall be tested at normal pressure for leakage. Long signal tubing shall be tested by charging each tube with air at 2 kg/ sq. cm. through a bubbler sight glass. The boiler draft and vacuum piping shall be air tested by the same method as long signal tubing.
7.00.00	**INSTRUMENT INSTALLATION**
	Instruments are not to be mounted directly on pipes etc. Transmitters , Temperature elements, switches, devices, etc. mounted in the field shall be suitably grouped together to the extent possible and mounted In local instrument racks with suitable canopy near to the instrument source connection point. These local instrument racks shall be furnished as per the actual requirements finalised during detailed engineering stage. The exact construction details of local instrument racks with canopy shall be finalised during detailed engineering stage. Local instrument racks with canopy are to be furnished by the conractor on as required basis within his quoted lumpssum price.
8.00.00	**For Sea Water Applications following to be provided**

System/Line Description	Sea Water Applications
Piping Class	S
Impulse Pipe Material	ASTM-A 213 TP 316L

CLAUSE NO.	TECHNICAL REQUIREMENTS

Schedule (Size)	80(1/2 inch)
Materials for Fitting/Valve Body	ASTM-A 182 316L
Valve Stem Material	-do-
Rating of Piping/ Fittings	3000lb
Pr. Class of Valve	800

PART – B

SUB-SECTION – IIIC-04

INSTRUMENTATION CABLES

CLAUSE NO.	TECHNICAL REQUIREMENTS

INSTRUMENTATION AND POWER SUPPLY CABLE

1.00.00 **INSTRUMENTATION CABLE, POWER SUPPLY CABLE, INTERNAL WIRING AND ELECTRICAL FIELD CONSTRUCTION MATERIAL**

1.01.00 **General Requirements**

1.01.01 The Bidder shall supply, erect, terminate and test all instrumentation cables for control and instrumentation equipment/devices/systems included under Bidder's scope as illustrated in the enclosed Drg. No. 0000-999-POI-A-021 and ensuring completeness of the control system.

1.01.02 Any other application where it is felt that instrumentation cables are required due to system/operating condition requirements, are also to be provided by Contractor.

1.01.03 Other type of cables like fiber optic/co-axial cables for system bus, cables for connection of peripherals etc. (under Contractor's scope) are also to be furnished by the Contractor.

1.01.04 Contractor shall supply all cable erection and laying hardware from the main trunk routes like branch cable trays/sub-trays, supports, flexible conduits, cable glands, lugs, pull boxes etc. on as required basis for all the systems covered under this specification.

1.01.05 Wherever the quantity has been defined as on as required basis, the same are to be furnished by contractor on as required basis within his quoted lump sump price without any further cost implication to the Owner.

2.00.00 **Specification of Instrumentation cable**

1.02.00 **Common Requirements**

S. No.	Property	Requirement
1	Voltage grade	225 V (peak value)
2.	Codes and standard	Refer to clause no:1.00.00
3.	Continuous operation suitability	At 70 deg. C for all types of cables, and at 205 Deg C for Type-C cables.

CLAUSE NO.	TECHNICAL REQUIREMENTS

S. No.	Property	Requirement
4.	Marking	a) Progressive automatic on-line sequential marking of length in meters to be provided at every one meter on outer sheath. b) Marking to read 'FRLS' to be provided at every 5 meters on outer sheath except for Type-C cable c) Durable marking at intervals not exceeding 625 mm shall include manufacturer's name, insulation material, conductor's size, number of pairs, voltage rating, type of cable, year of manufacturer to be provided on outer sheath.
5.	Allowable Tolerance on overall diameter	+/- 2 mm (maximum) over the declared value in data sheet
6.	Variation in diameter	Not more than 1.0 mm throughout the length of cable.
7.	Ovality at any cross-section	Not more than 1.0 mm
8.	MAXI-TERMI suitability	To be provided
9.	Color	The outer sheath shall be of blue color.
10.	Others	a) Cables shall be suitable for laying in conduits, ducts, trenches, racks and underground-buried installation b) Repaired cables shall not be acceptable.

1.03.00 **Specific Requirements**

Specification Requirements	Type-A cable	Type-B cable	Type F & G cable	Type-C cable
A. Conductors				
Cross section area	0.5 sq. mm			
Conductor material	ANSI type KX	ANSI type SX	Annealed bare copper	ANSI type KX
Colour code	Yellow-Red	Black-Red	As per VDE-815	Yellow-Red

CLAUSE NO.	TECHNICAL REQUIREMENTS			
	Conductor Grade	As per ANSI MC 96.1	Electrolytic	As per ANSI MC 96.1
	No & dia of strands	7x0.3 mm (nom)		
	No. of Pairs	As mentioned in contract quantities		
	Max. conductor loop resistance per Km (in ohm) at 20 deg. C	As per ANSI MC 96.1	73.4	As per ANSI MC 96.1
	Reference Standard	As per ANSI MC 96.1	VDE-815	As per ANSI MC 96.1
	B. Insulation			
	Material	Extruded PVC type YI 3		Teflon (i.e. extruded FEP)
	Thickness in mm (Min/Max)	0.25/0.35		0.4 / 0.50 (nominal)
	Volume Resistivity (Min) in ohm-cm	1 x 10^{14} at 20 deg. C & 1x10^{11} at 70 deg. C.		2.8x 10^{14} at 20 deg. C & 2x10^{11} at 205 deg. C.
	C. Pairing & Twisting			
	Max. lay of pairs (mm)	50		
	Single layer of binder tape on each pair provided	Each core printed with number or Numbered binder tape to provided on each pair	Yes	Each core printed with number or Numbered binder tape to be provided on each pair
	Bunch (Unit Formation) for more than 4P	N.A	To be provided	N.A
	Conductor /pair identification as per VDE0815	N.A.	To be provided	N.A.
	D. Shielding			
	Type of shielding	Al-Mylar tape		

CLAUSE NO.	TECHNICAL REQUIREMENTS

Individual pair shielding	No	To be provided for F-type cable	No
Minimum thickness of Individual pair shielding	No	0.028mm (28 micron)	No
Overall cable assembly shielding	To be provided		
Minimum thickness of Overall cable assembly shielding	0.055 mm (55 micron)		
Coverage Overlapping	20%		
Drain wire provided for individual shield	N.A.	Yes (for F-type) Size- 0.5 sqmm No of strands-7 Dia of strands- 0.3mm Annealed Tin coated copper	N.A.
Drain wire provided for overall shield	Yes. Size- 0.5 sqmm No of strands-7 Dia of strands- 0.3mm Annealed Tin coated copper		
E. FILLERS (if applicable)			
Non-hygroscopic, flame retardant	To be provided		
F. Outer Sheath			
Material	Extruded PVC compound YM1 with FRLS properties		Teflon (i.e. extruded FRP)
Minimum Thickness at any point	1.8 mm		0.4 mm
Nominal Thickness at any point	>1.8 mm		0.5 mm
Resistant to water, fungus, termite & rodent attack	Required		

CLAUSE NO.	TECHNICAL REQUIREMENTS

Minimum Oxygen index as per ASTMD-2863	29 %		N.A.
Minimum Temperature index as per ASTMD-2863	250 deg.C		N.A.
Maximum Acid gas generation by weight as per IEC-60754-1	20%		N.A.
Maximum Smoke Density Rating as per ASTMD-2843	60% (defined as the average area under the curve when the results of smoke density test plotted on a curve indicating light absorption vs. time as per ASTMD-2843)		N.A.
Reference standard	VDE207 Part 5, VDE-816		VDE207 Part 6 & ASTM D2116
G. Electrical Parameters			
Mutual Capacitance Between Conductors At 0.8 Khz (Max.)	200 nF/km	120 nF/km for F type 100 nF/km for G-type	200 nF/km
Insulation Resistance (Min.)	100 M Ohm/Km		
Cross Talk Figure (Min.) At 0.8 Khz	60 dB	60 dB	60dB
Characteristic Impedance (Max) At 1 Khz	N.A.	320 OHM FOR F-TYPE 340 OHM FOR G-TYPE	N.A.
Attenuation Figure At 1 Khz (Max)	N.A.	1.2 db/km	N.A.
H. Complete Cable			
Complete Cable assembly	Shall pass Swedish Chimney test as per SEN-SS 4241475 class F3.		N.A.
Flammability	Shall pass flammability as per IEEE-383 read in conjunction to this specification		As per manufacturer's standard subject to employer's approval

CLAUSE NO.	TECHNICAL REQUIREMENTS

I. Accessories		
Cable accessories of flame retardant quality.	Yes. (Accessories such as harnessing components, markers, bedding, cable jointer, binding tape etc.)	
J. Cable Drum		
Type	Non-returnable wooden drum (wooden drum to be constructed from seasoned wood free from defects with wood preservative applied to the entire drum) or steel drum. For type-C cables, drums of other material as per manufacturers practice can be provided subjected to employers approval.	
Outermost layer covered with waterproof paper	Yes	
Painting	Entire surface to be painted	
Length	1000 m ± 5% for up to & including 12 pairs 500 m ± 5% for above12 pairs	
Drum Marking	Manufacturer's name, Employer's name, address and contract number, item no., type, size and length of the cable, net and gross weight stenciled, Reference to National/International Standard, Operating Voltage, Country & Year of Manufacture on drum.	

3.00.00 **SPECIFICATION OF OPTICAL FIBER CABLES (OFC)**

3.01.00 Optic Fiber cable shall be 4/8/12 core, galvanised corrugated steel taped armoured, fully water blocked with dielectric central member for outdoor/indoor application so as to prevent any physical damage. The cable shall have multiple single-mode or multi mode fibers on as required basis so as to avoid the usage of any repeaters. The core and cladding diameter shall be 9 +/- 1 micrometer and 125 +/- 1 micrometer respectively. The outer sheath shall have Flame Retardant, UV resistant properties and are to be identified with the manufacturer's name, year of manufacturer, progressive automatic sequential on-line marking of length in meters at every meter on outer sheath.

3.02.00 The cable core shall have suitable characteristics and strengthening for prevention of damage during pulling viz. Steel central member, Loose buffer tube design, 4 fibers per buffer tube (minimum), Interstices and buffer tubes duly filled with Thixotropic jelly etc. The cable shall be suitable for a maximum tensile force of 2000 N during installation, and once installed, a tensile force of 1000 N minimum. The compressive strength of cable shall be 3000 N minimum& crush resistance 4000 N minimum. The operating temperature shall be –20 deg. C to 70 deg.C.

CLAUSE NO.	TECHNICAL REQUIREMENTS
3.03.00	All testing of the fiber optic cable being supplied shall be as per the relevant IEC, EIA and other international standards.
3.04.00	Bidder to ensure that minimum 100% cores are kept as spares in all types of optical fibre cables.
3.05.00	Cables shall be suitable for laying in conduits, ducts, trenches, racks and under ground buried installation.
3.06.00	Spliced / Repaired cables are not acceptable.
3.07.00	Penetration of water resistance and impact resistance shall be as per IEC standard.
4.00.00	**INSTRUMENTATION CABLE INTERCONNECTION AND TERMINATION PHILOSOPHY** The cable interconnection philosophy to be adopted shall be such that extensive grouping of signals by large scale use of field mounted Group Junction Boxes (JBs) at strategic locations (where large concentration of signals are available, e.g. valves limit & torque switches, switchgear) is done and consequently cable with higher number of pairs are extensively used. The details of termination to be followed are mentioned in the given Table A. TABLE A: CABLE TERMINATION TO BE FOLLOWED

Application		Type Of Termination		Type Of Cable
FROM (A)	TO (B)	END A	END B	
Valves/dampers drives (Integral Junction box)	Marshalling cubicle/ Marshalling cum termination Cubicle/local group JB	Plug in connector	Posts mount cage clamp type.	G
Transmitters, Process Actuated switches mounted in LIE/LIR	Integral Junction box of LIE/LIR	Plug in connector	Cage clamp (Rail mount) type.	F,G
RTD heads	Local junction box	Plug in connector	Cage clamp (Rail mount) type.	F
Thermocouple	CJC Box (if applicable)	Plug in connector	Cage clamp (Rail mount) type.	A,B,C*
Other Field Mounted Instrument	Local JB/Group JB	Plug in connector	Screwed, Cage clamp (Rail mount) type	F,G
RTD	Temperature transmitter	Plug in connector	Screwed, Cage clamp type	F

CLAUSE NO.	TECHNICAL REQUIREMENTS

Thermocouple	Temperature transmitter	Plug in connector	Screwed, Cage clamp type	A,B,C*
Local Junction box, Temperature Transmitter, Int. Junction box of LIE/ LIR/Group JB/ MCC/SWGR	Group JB	Cage clamp (Rail mount) type.	Cage clamp (Rail mount) type.	F,G
Local Junction box, Temperature Transmitter, Int. Junction box of LIE/ LIR/Group JB/ MCC/SWGR	Marshalling Cubicle/ Marshalling cum Termination Cabinet	Cage clamp (Rail mount) type.	Posts mount cage clamp type.	F,G
Marshalling cubicle/ Termination Cabinet	Electronic system cabinet	Cage clamp Post mounted type.	Plug in connector/Other System as per manufacturer's Standard	Internal wiring
Marshalling/ Termination System Cabinets	UCD mounted equipments	Post mount cage clamp type.	Plug in connector/Cage clamp type (rail mounted).	F,G (with plug-in connector at one end)
DDCMIS/PLC cabinets	PC, Printers etc.	Plug in connector	Plug in connector	Mfr.'s Standard

Notes

1. Normally 10% spare cores shall be provided when the numbers of pairs of cables are more than four pairs except for pre-fabricated cables which shall be as per manufacturer's standard.
2. For analog signals, individual pair shielding & overall shielding & for Binary signals, only overall shielding of instrumentation cables shall be provided.
3. Also refer drg. 0000-999-POI-A-021.
4. *For high temperature applications only.

5.00.00 TERMINAL BLOCKS

5.01.00 All terminal blocks shall be rail mounted/post mounted, cage clamp type with high quality non-flammable insulating material of melamine suitable for working temperature of 105 deg. C. The terminal blocks in field mounted junction boxes, temperature transmitters, instrument enclosures/racks, etc., shall be suitable for cage clamp connections. The terminal blocks in Control Equipment Room logic/termination/marshalling cubicles shall be suitable for post mounted cage clamp connection at the field input end. The terminal blocks for DDCMIS input/output connections from/to SWGR/MCC, Actuators with Integral Starter (for coupling relays and check back signals of 11 kV and 3.3 kV auxiliaries, LT drives/valves & dampers/solenoids, CT & VT, etc.) shall be provided with built in test and disconnect facilities complete with plug, slide clamp, test socket etc. The exact type of terminal

CLAUSE NO.	TECHNICAL REQUIREMENTS
	blocks to be provided by the Bidder and the technical details of the same including width etc. shall be subject to Employer's approval.
5.02.00	All the terminal blocks shall be provided complete with all required accessories including assembly rail, locking pin and section, end brackets, partitions, small partitions, test plug bolts and test plug (as specified above for SWGR connections) transparent covers, support brackets, distance sleeves, warning label, marking, etc.
5.03.00	The marking on terminal strips shall correspond to the terminal numbering on wiring diagrams. At least 20% spare unused terminals shall be provided everywhere including local junction boxes, instrument racks/enclosures, termination/marshalling cabinets, etc. All terminal blocks shall be numbered for identification and grouped according to the function. Engraved labels shall be provided on the terminal blocks.
5.04.00	For terminating each process actuated switches, drive actuators, control valves, Thermocouple, RTD, etc. in Local Junction Boxes, etc, refer Drg no.s 0000-999-POI-A-065, 0000-999-POI-A-065A.
5.05.00	The terminal blocks shall be arranged with at least 100 mm clearance between two sets of terminal blocks and between terminal blocks and junction box walls.
5.06.00	For ensuring proper connections, Bidder shall provide suitable accessories, along with insulation sleeves. The exact connecting accessory shall be finalised as per application during detail engineering stage subject to Employer's approval without any cost repercussions.
5.07.00	Internal wiring in factory pre-wired electronic equipment cabinets may be installed according to the Bidder's standard as to wire size and method of termination or internal equipment. Terminal blocks for connection of external circuits into factory prewired electronic equipment cabinets shall meet all the requirements as specified above.
6.00.00	**INTERNAL PANELS/ SYSTEM CABINETS WIRING**
6.01.00	Internal panel/cabinet wiring shall be of multi-stranded copper conductor with FRLS PVC insulation without shield and outer sheath meeting the requirements of VDE 0815.
6.02.00	Wiring to door mounted devices shall be done by 19 strand copper wire provided with adequate loop lengths of hinge wire so that multiple door opening shall not cause fatigue breaking of the conductor.
6.03.00	All internal wires shall be provided with tag and identification nos. etched on tightly fitted ferules at both ends in Employer's approved format. All wires directly connected to trip devices shall be distinguished by one additional red colour ferrule.
6.04.00	All external connection shall be made with one wire per termination point. Wires shall not be tapped or spliced between terminal points.
6.05.00	All floor slots of desk/panels/cabinets used for cable entrance shall be provided with removable gasketed gland plates and sealing material. Split type grommets shall be used for prefabricated cables.

CLAUSE NO.	TECHNICAL REQUIREMENTS
6.06.00	All the special tools as may be required for solder less connections shall be provided by Bidder.
6.07.00	Wire sizes to be utilised for internal wiring. (i) Current (4-20 mA), low voltage signals (48V); Ammeter/Voltmeter circuit, control switches etc. for electrical system. — 0.5 Sq.mm. (ii) Power supply and internal illumination. — 2.5Sq.mm. minimum (shall be as per load requirement.)
7.00.00	**INSTRUMENTATION CABLE INSTALLATION AND ROUTING**
7.01.00	All cables assigned to a particular duct/conduit shall be grouped and pulled in simultaneously using cable grips and suitable lubricants. Cables removed from one duct/conduit shall not be reused without approval of Employer.
7.02.00	Cables shall be segregated as per IEEE Std.-422. In vertically stacked trays, the higher voltage cable shall be in higher position and instrumentation cable shall be in bottom tier of the tray stack. The distance between instrumentation cables and those of other system shall be as follows: From 11 kV/6.6 kV/3.3 kV tray system - 914 mm From 415V tray system - 610 mm From control cable tray system - 305 mm
7.03.00	Cables shall terminate in the enclosure through cable glands. All cable glands shall be properly gasketed. Fire proof sealing (to prevent ingress of dust entry and propagation of fire) shall be provided for all floor slots used for cable entrance. Compression cable glands (double for armoured and single for other cables) shall be provided.
7.04.00	All cables shall be identified by tag. Nos. provided in Employer's approved format at both the ends as well as at an interval of 5 meters.
7.05.00	Line voltage drop due to high resistance splices, terminal contacts, insulation resistance at terminal block, very long transmission line etc. shall be reduced as far as practicable.
706.00	The cables emanating from redundant equipment/devices shall be routed through different paths. The above segregation of cables & wiring for redundant equipments/devices shall be in accordance with IEEE-Std-422.
8.00.00	**CABLE LAYING AND ACCESSORIES**
8.01.00	**CABLE LAYING** 1 Cables shall be laid strictly in line with cable schedule. 2 Identification tags for cables.

CLAUSE NO.	TECHNICAL REQUIREMENTS

Indelible tags to be provided at all terminations, on both sides of wall or floor crossing, on each conduit/duct/pipe entry/exit, and at every 20 m in cable trench/tray.

3 Cable tray numbering and marking.

To be provided at every 10m and at each end of cable way & branch connection.

4 Joints for less than 250 Meters run of cable shall not be permitted.

5 Buried cable protection

With concrete slabs; Route markers at every 20 Meters along the route & at every bend.

6 Road Crossings

Cables to pass through buried high density PE pipes encased in PCC. At least 300 mm clearance shall be provided between

- HT power & LT power cables,
- LT power & LT control cables
- LT control & instrumentation cables,

Spacing between cables of same voltage grade shall be in accordance with the derating criteria adopted for cable sizing.

7 Segregation (physical isolation to prevent fire jumping)

a All cable associated with the unit shall be segregated from cables of other Units.

b Interplant cables of station auxiliaries and unit critical drives shall be segregated in such a way that not more than half of the drives are lost in case of single incident of fire.

8 Cable clamping

All cables laid on trays shall be neatly dressed up & suitably clamped/tied to the tray. For cables in trefoil formation, trefoil clamps shall be provided.

9 **Optical fiber cables inside conduit shall be laid on cable trays wherever available and feasible. In areas where the same are required to be buried, the same shall be buried in separate trench approx.1.6 meter depth, to be laid in 2" GI/rodent proof HDPE conduits covered with sand, brick and soil along the pipe line route;**

While crossing roads - to be laid in GI/rodent proof HDPE conduits with sand filling at bottom and sand, soil filling at top with cement concrete;

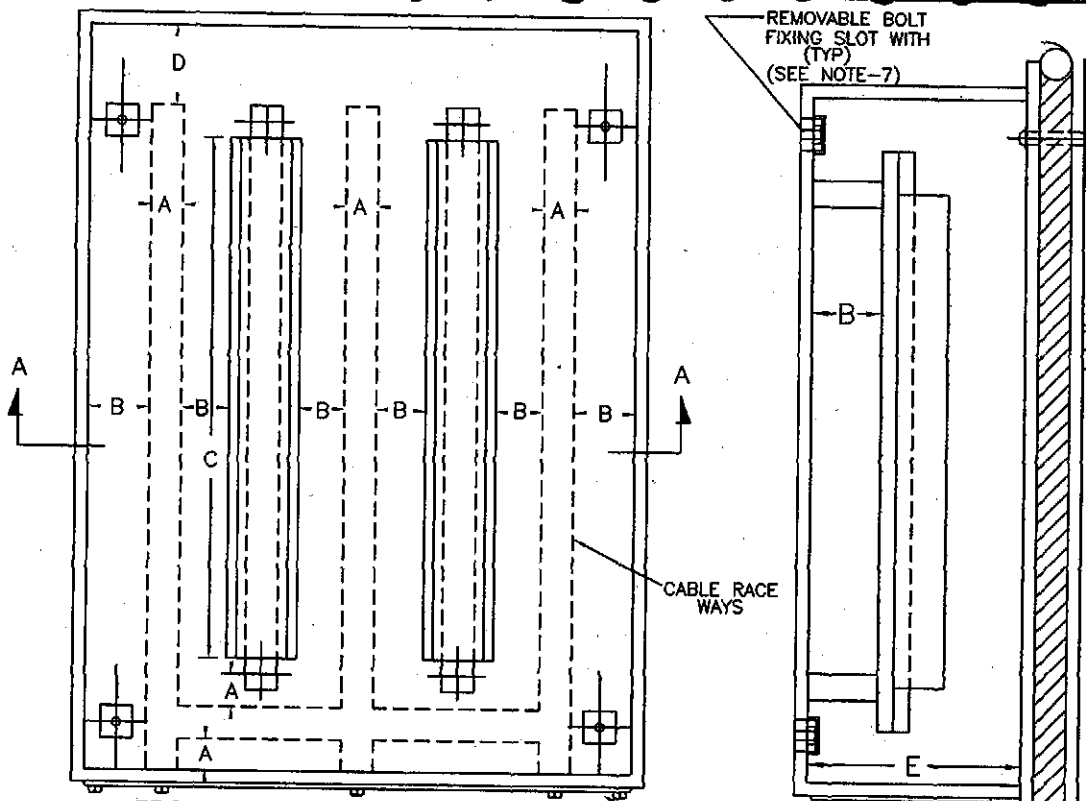
While crossing canals/river- to be laid in GI/rodent proof HDPE conduits within hume pipe.

CLAUSE NO.	TECHNICAL REQUIREMENTS
8.02.00	Bidder shall supply and install all cable accessories and fittings like Light Interface Units, Surge suppressors, Opto isolators, Interface Converters, Fibre Optic Card Cage, Fibre Optic Line Driver, Repeater / Modem (for Optical Fibre Cables), cable glands, grommets, lugs, termination kits etc. on as required basis.
8.03.00	Bidder shall furnish two completely new sets of cable termination kits like Crimping tools, etc., which are required for maintenance of the system as per the type of termination used.
8.04.00	Cables, which terminate in cabinets of draw out sections shall have sufficient cable coiled in the bottom of the cabinet to permit full withdrawal of draw out sections without disconnecting the cables. When prefabricated cables with factory connectors on both ends are longer than required, the excess cable shall be coiled in the bottom of one or both termination cabinets.
8.05.00	No splices shall be made in conductors for instrument and control circuits except where required at connections to devices equipped with factory installed pigtails. Such splices shall be made only in approved splicing boxes of fitting with removable cover. The splices shall be made with sufficient slack left in the wires to permit withdrawal of the splice from the splicing box for ease of future disconnection of the splices. All exposed conductor or connector surfaces shall be covered with a minimum of three half-lapped layers of all weather vinyl plastic electrical tape. Taping shall extend a minimum of two cable diameters over the cable jacket and a similar distance over the other insulation or connections requiring insulation.
8.06.00	The Bidder shall be responsible for proper grounding of all equipment under this package. Further, proper termination of cable shields shall be verified and the grounding of the same shall be coordinated so as to achieve grounding of all instrumentation cable shields at same potential. This shall be completed prior to system tests. All the cables etc. required for grounding of all equipments supplied under this package are to be supplied by the Bidder.
8.07.00	The Contractor shall take full care while laying / installing cables as recommended by cable manufacturers regarding pulling tensions and cable bends. Cables damaged in any way during installation shall be replaced at the expense of the Contractor.
9.00.00	**FIELD MOUNTED LOCAL JUNCTION BOXES**
	(i) No. of ways: 12/24/36/48/64/72/96/128 with 20% spares terminals.
	(ii) Material and Thickness: 4mm thick Fiberglass Reinforced Polyester (FRP).
	(iii) Type: Door gasket shall be of synthetic rubber.
	(iv) Mounting clamps and accessories: Suitable for mounting on walls, columns, structures etc. The brackets, bolts, nuts, screws, glands and lugs required for erection shall be of brass, included in Bidders scope of supply. Raceways shall be provided inside JBs for proper termination of cables.
	(v) Type of terminal blocks: Rail mounted cage-clamp type suitable for conductor size upto 2.5 mm^2. A M6 earthing stud shall be provided.

CLAUSE NO.	TECHNICAL REQUIREMENTS
	(vi) Protection Class — IP: 55 minimum for indoor & IP-65 minimum for outdoor applications. (vii) Grounding — To be provided. (viii) Color — To be decided during detailed engineering & subject to Employer's approval.
10.00.00	**CONDUITS**
10.01.00	Conduits shall be generally used for interconnecting cables from field instruments to Local JB's. All rigid conduits, couplings and elbows shall be hot dipped galvanised rigid mild steel in accordance with IS: 9537 Part-I (1980) and Part-II (1981). The conduit interior and exterior surfaces shall have continuous zinc coating with an overcoat of transparent enamel lacker or zinc chromate. Flexible conduit shall be heat resistant lead coated steel, water leak, fire and rust proof. The temperature rating of flexible conduit shall be suitable for application areas. For remaining applications, water leak, fire & rust proof flexible C.I conduits shall be provided.
10.02.00	The Bidder shall install conduits according to the general routing as approved by Employer and shall coordinate conduit locations with other works.
10.03.00	All grounding bushings within all enclosures shall be wired together and connected internally to the enclosure grounding lug or grounding bus with 8 AWG bare copper conductor. Conduit runs to individually mounted equipment shall be grounded to the Employer's cable tray grounding conductor with 12 AEG bare copper conductor. All grounding bushings, clamps and connectors shall be subject to approval of the Employer.
10.04.00	All rigid conduit fittings shall conform to the requirements of IS: 2667, 1976. Galvanized steel fitting shall be used with steel conduit. All flexible conduit fittings shall be liquid tight, galvanized steel. The end fittings shall be compatible with the flexible conduit supplied.
10.05.00	All individually mounted equipment and devices shall be connected to the supply conduit, using not more than one meter of flexible conduit adjacent to the equipment or device. Flexible conduit shall be installed in all conduit runs, which are supported by both building steel and structures subject to vibration or thermal expansion. This shall include locations where conduit supported by building steel enters or becomes supported by the turbine generator foundation and where conduit supported by building steel or foundation becomes supported by steam generator framing.
10.06.00	Special areas, such as control rooms in which external noise is to be minimized, shall have flexible conduit in conduit runs where the runs cross from the main building framing to the control room framing.
10.07.00	Conduit supports shall be furnished and installed in accordance with these specifications. Support material shall comply with the following requirements. i) Hanger rods shall be 12 mm diameter galvanized threaded steel rods. ii) Single conduit supports shall be one-hole cast metal straps and clamp backs unless other types are acceptable to the Employer. Multiple conduit bank

CLAUSE NO.	TECHNICAL REQUIREMENTS
	supports shall be constructed of special galvanized support channels with associated conduit clips.
10.08.00	Conduit sealing, explosion proof, dust proof and other types of special fittings shall be provided as required by these specifications and shall be consistent with the area and equipment with which they are installed. Fittings installed outdoors and in damp locations shall be sealed and gasketed. Hazardous area fittings and conduits sealing shall conform to NEC requirements for the area classification.
10.09.00	Contractor shall provide double locknuts on all conduit terminations not provided with threaded hubs and couplings. Water tight conduit unions and rain tight conduit hubs shall be utilised for all the application which shall be exposed to weather. Moisture pockets shall be eliminated from conduits.
10.10.00	Conduits shall be securely fastened to all boxes and cabinets.
11.00.00	**CABLE SUB-TRAY & SUPPORT**
11.01.00	The cable sub-trays and the supporting system, to be generally used between Local/Group JBs and the main cable trays and the same shall be furnished and installed by the Contractor. It is the assembly of sections and associated fittings forming a rigid structural system used to support the cable from the equipment or instrument enclosure upto the main cable trays (trunk route).
11.02.00	The covers on the cable sub-trays shall be used for protection of cables in areas where damage may occur from falling objects, welding spark, corrosive environment, etc. & shall be electrically continuous and solidly grounded. The cable trays shall not have sharp edges, burrs or projections injurious to the insulation or outer sheath of the cables.
11.03.00	The supporting arrangement of cable tray system shall be able to withstand the weight of the cable and cable tray system. The supporting interval shall not be more than the recommended span for the above loading for the type of cable tray selected. The tray shall not overhang by more than one meter from the support at the dead end. As far as practicable the cable sub-tray system shall be supported from one side only, in order to facilitate installation and maintenance of cables.
11.04.00	The Bidder shall furnish and install the estimated quantities and sizes of sub trays/troughs including all required fittings and adaptors on as required basis.
12.00.00	Following C & I drawings referred in this sub-section are enclosed herewith.

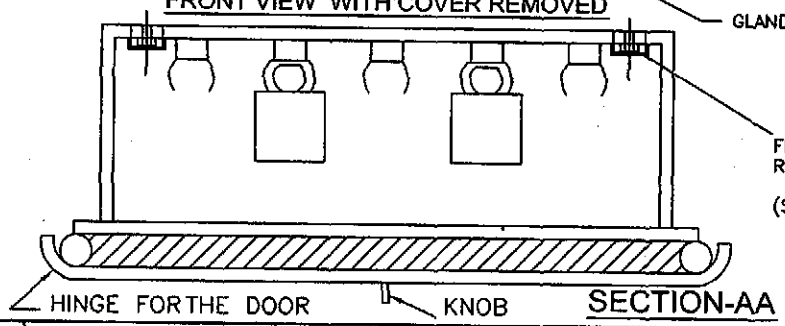
Sl. No.	Drawing No.	Sht Nos	Drawing Title
1	0000-999-POI-A-017	1	Local Junction box details
2	0000-999-POI-A-021	2	Instrumentation cabling philosophy
3	0000-999-POI-A-063	1	Interfacing of Actuator
4	0000-999-POI-A-065	1-14	Interfacing of field Instruments



A – 75 mm
B – 25 mm
C – SEE NOTE-4
D – 100 mm
E – 150 mm

NOTES:-

1. JUNCTION BOXES SHALL HAVE GLAND PLATES AT THE BOTTOM OF THE BOX ONLY.
2. TUBULAR TYPE GASKETS WILL BE USED.
3. FRP JUNCTION BOXES, SHALL BE PROVIDED WITH POLYEUTHERENE COATING. ALSO REFER SUB SECTION INST CABLE, PART-B SECTION-VI FOR DETAILES.
4. DIMENSION OF 'F' SHALL BE BASED ON NO. OF TERMINAL BLOCKS.
5. THE EXACT TYPE & DIMENSION OF JUNCTION BOXES TO BE USED FOR A PARTICULAR APPLICATION SHALL BE AS DECIDED DURING DETAIL ENGG. STAGE AND SHALL BE SUBJECT TO EMPLOYER's APPROVAL WITHOUT ANY PRICE REPERCUSSION.
6. THE KNOB FOR ALL THE JUNCTION BOXES SHALL BE IDENTICAL.
7. ANY TYPE OF SEALED FIXING ARRANGEMENT AS PER MANUFACTURER's STANDARD CAN ALSO BE PROVIDED SUBJECT TO EMPLOYER's APPROVAL.



FOR TENDER PURPOSE ONLY

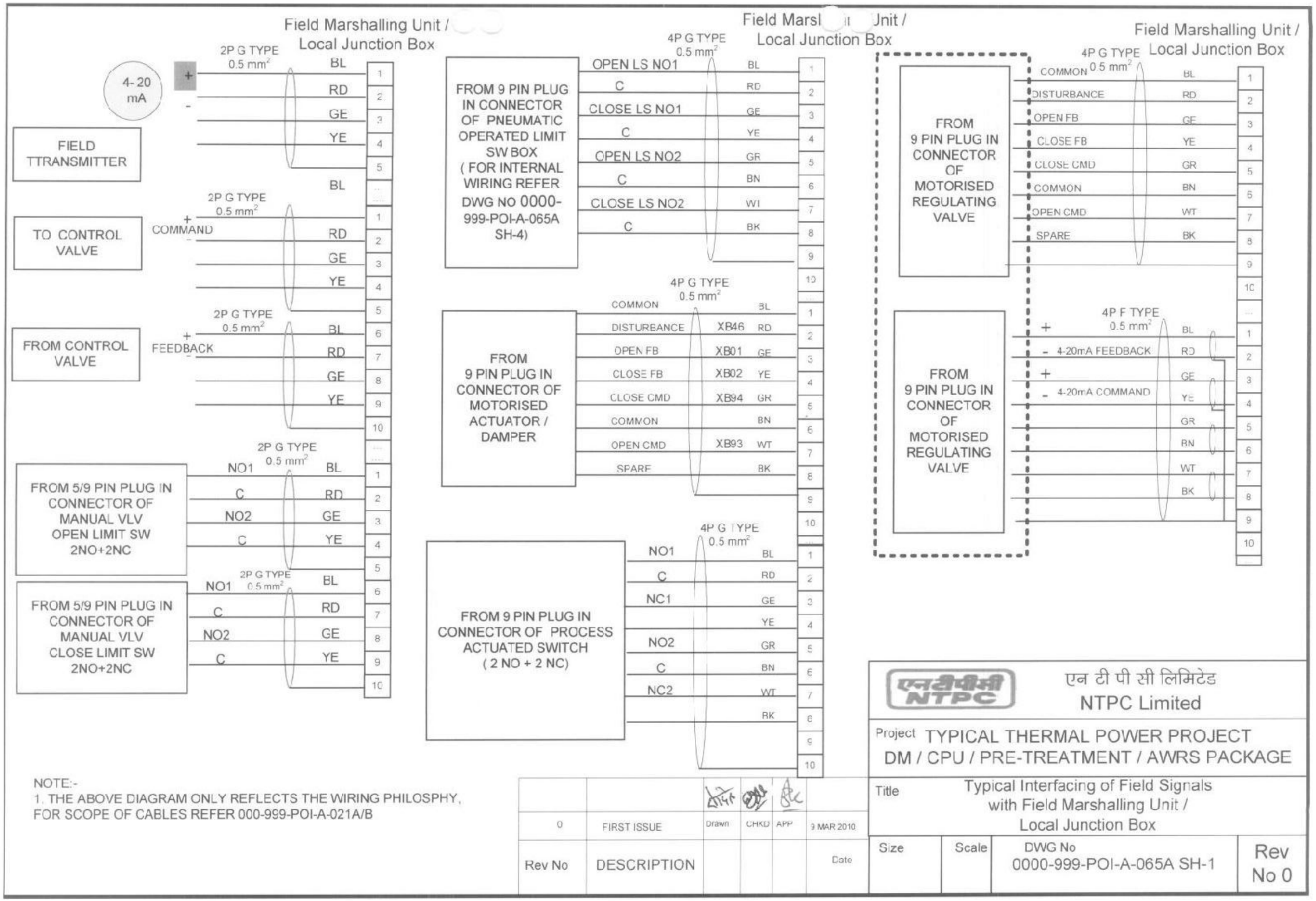
REV.NO.	DESCRIPTION	DRAWN	DESIGN	CHKD.	M	E	C	C&I	ARCH.	APPD	DATE
D	GENERALLY REVISED		JM	KS							30.11.05
C	GENERALLY REVISED		JM	KS							04.08.06
B	GENERALLY REVISED	S.K.	A.R	PS							
A	FIRST ISSUE	S.K.	A.R	PS							04.05.05

CLEARED BY

PROJECT: TYPICAL THERMAL POWER PLANT

TITLE: LOCAL JUNCTION BOX CONNECTION DETAILS

SIZE	SCALE	DRG. NO.	REV. NO.
A3	N.T.S.	0000-999-POI-A-017	D



NOTE:-
1. THE ABOVE DIAGRAM ONLY REFLECTS THE WIRING PHILOSPHY, FOR SCOPE OF CABLES REFER 000-999-POI-A-021A/B

Rev No	DESCRIPTION	Drawn	CHKD	APP	Date
0	FIRST ISSUE				9 MAR 2010

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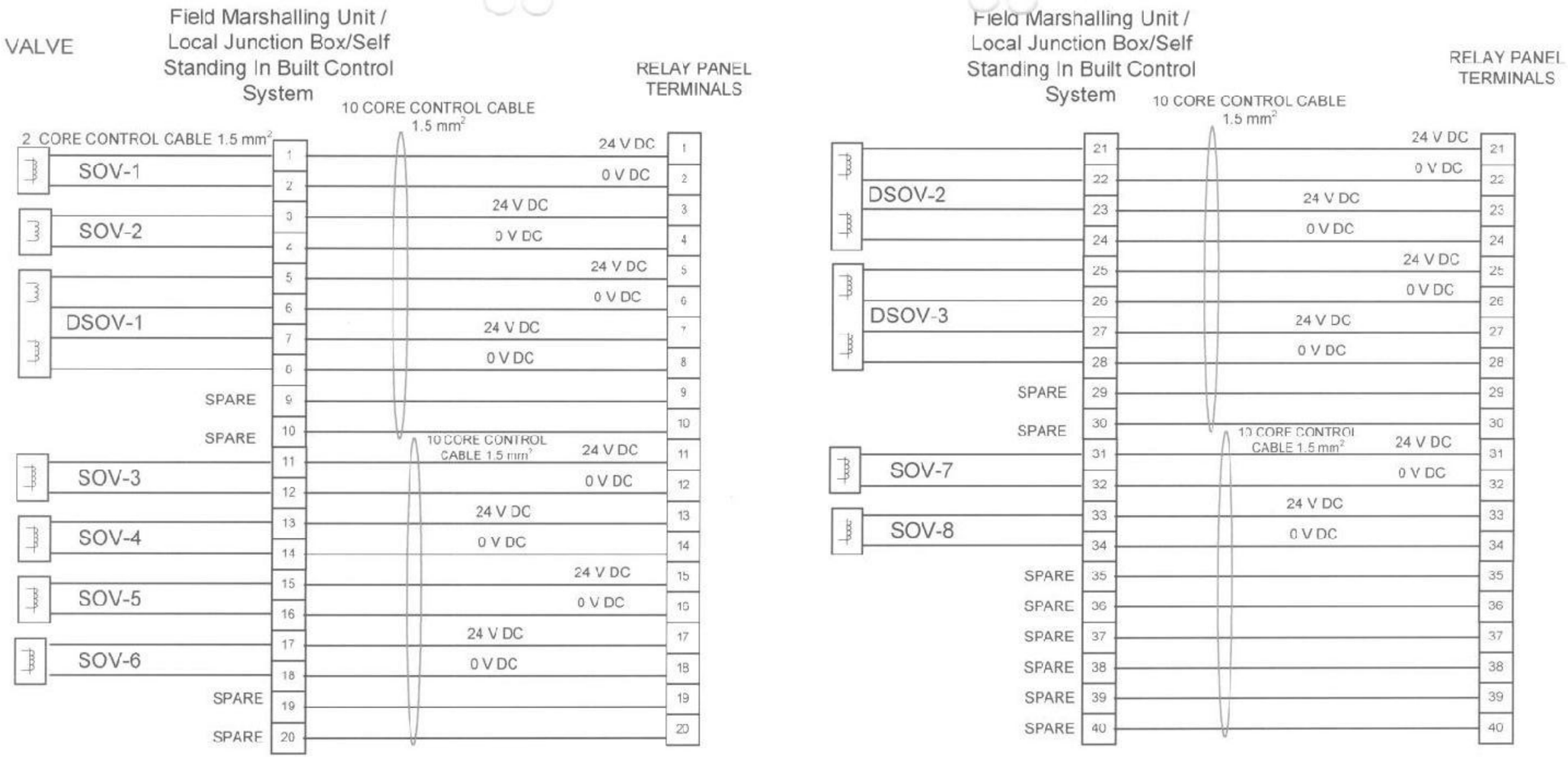
Project: TYPICAL THERMAL POWER PROJECT
DM / CPU / PRE-TREATMENT / AWRS PACKAGE

Title: Typical Interfacing of Field Signals with Field Marshalling Unit / Local Junction Box

Size	Scale	DWG No	Rev No
		0000-999-POI-A-065A SH-1	0



NOTE:-
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Rev No	DESCRIPTION	Drawn	CHKD	APP	Date
0	FIRST ISSUE				9 MAR 2010

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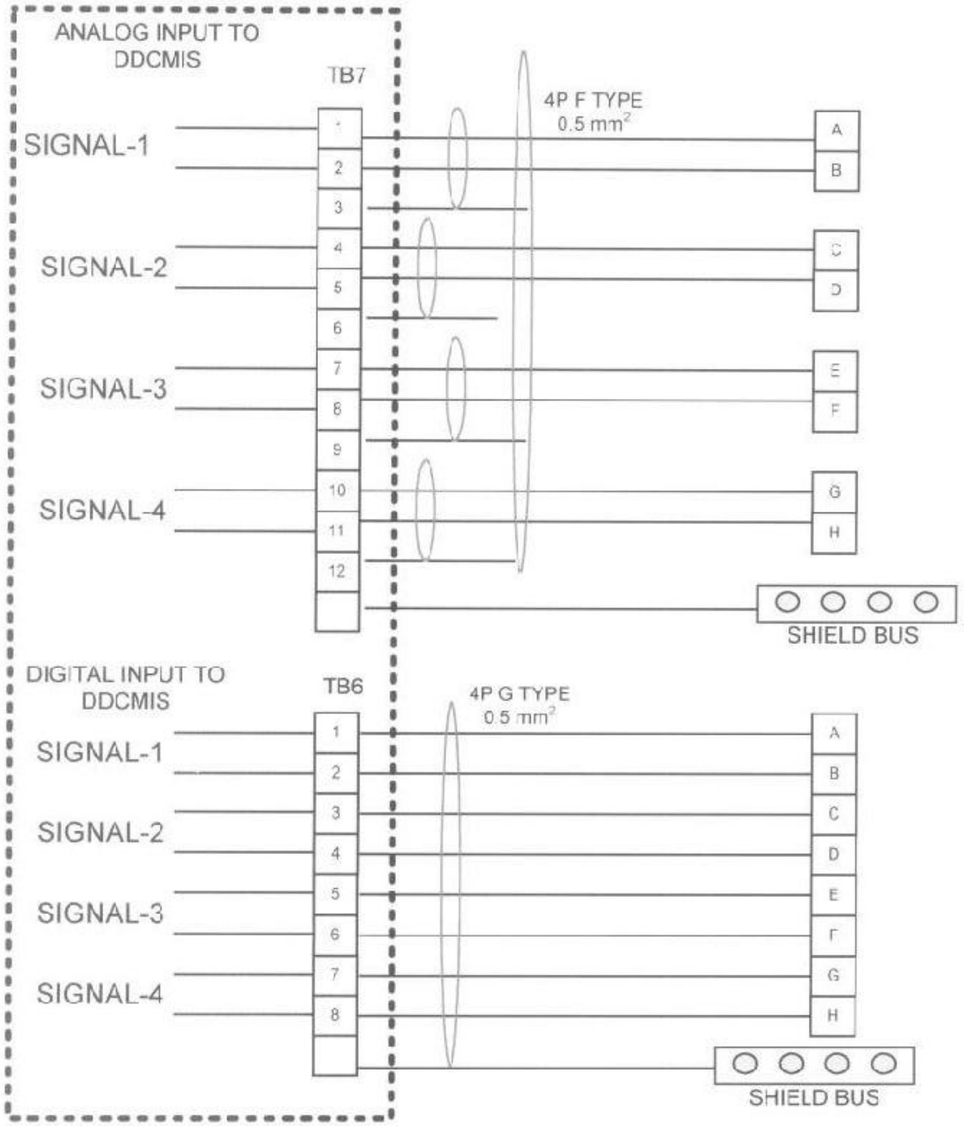
DM / CPU / PRE-TREATMENT / AWRS PACKAGE

Title: Typical Interfacing of Field Signals with Field Marshalling Unit / Local Junction Box

Size	Scale	DWG No	
		0000-999-POI-A-065A SH-2	REV-0

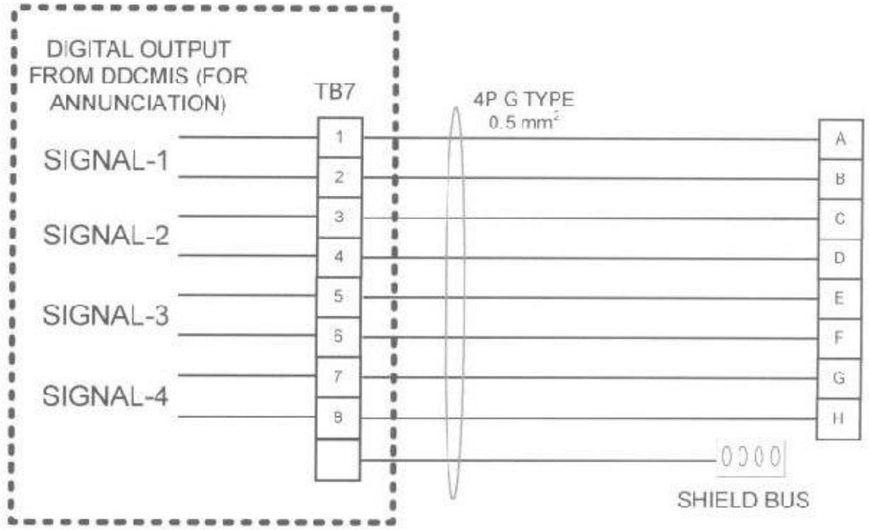
SELF STANDING IN BUILT CONTROL SYSTEM

MARSHALLING CABINET OF DDCMIS



SELF STANDING IN BUILT CONTROL SYSTEM

MARSHALLING CABINET OF DDCMIS



NOTE:-
1. THE EXACT TB TERMINATION DETAILS OF SELF STANDING IN BUILT CONTROL SYSTEM PANEL FOR INTERFACING WITH DDCMIS WILL BE PROVIDED BY EMPLOYER
2. THE ABOVE DIAGRAM ONLY REFLECTS THE WIRING PHILOSPHY, FOR SCOPE OF CABLES REFER 000-999-POI-A-021A/B

Rev No	DESCRIPTION				Date
0	FIRST ISSUE	Drawn	CHKD	APP	9 MAR 2010

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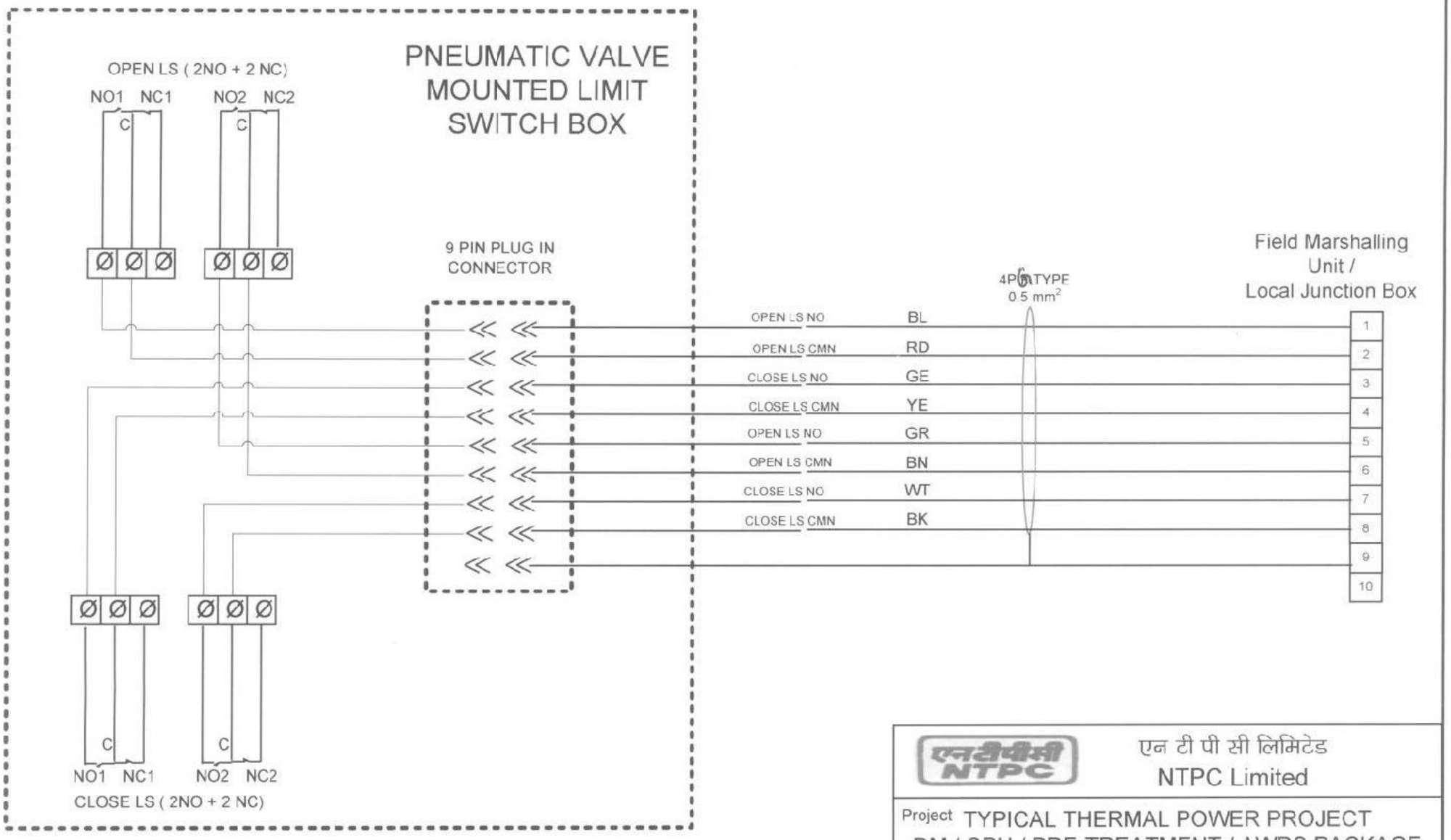
Project: TYPICAL THERMAL POWER PROJECT
DM / CPU / PRE-TREATMENT / AWRS PACKAGE

Title: Typical Interfacing of Field Signals with Field Marshalling Unit / Local Junction Box

Size	Scale	DWG No	
		0000-999-POI-A-065A SH-3	REV-0



NOTE:-
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Rev No	DESCRIPTION	Drawn	CHKD	APP	Date
0	FIRST ISSUE				9 MAR 2010

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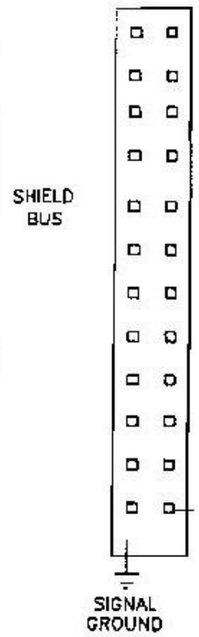
NTPC Limited

Project: TYPICAL THERMAL POWER PROJECT
DM / CPU / PRE-TREATMENT / AWRS PACKAGE

Title: Typical Interfacing of Field Signals with Field Marshalling Unit / Local Junction Box

Size	Scale	DWG No	Rev No
		0000-999-POI-A-065A SH-4	0

MARSHALLING/ TERMINATION CUBICLES — 4 PAIR, 0.5 Sq. mm — MCC/SWGR D



02	BL	04	
04	RD	06	Q, K3 — MCC DISTURBANCE
		05	K3, Q — MCC DISTURBANCE
		07	
06	GE	08	42a — STATUS 'ON'
08	YE	09	42b — STATUS 'OFF'
10	GR	01	K11 — COMMAND 'OFF'
12	BN	03	
14	WT	02	K12 — COMMAND 'ON'
16	BK		
		13	
		14	49 — OVERLOAD TRIP OPERATED FOR OTHER SYSTEMS (WHERE REQUIRED)
		15	
		17	
		16	EMERGENCY PUSH BUTTON OPERATED FOR OTHER SYSTEMS (WHERE REQUIRED)
		10	
		11	42 — STATUS ON/OFF FOR OTHER SYSTEMS (WHERE REQUIRED)
		12	42

NOTE

1. FOR CHP DRIVES, THE SCHEME SHALL BE FINALISED DURING DETAILED ENGG.

FOR TENDER PURPOSE ONLY

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NTPC LIMITED
(A GOVERNMENT OF INDIA ENTERPRISE)
ENGINEERING DIVISION

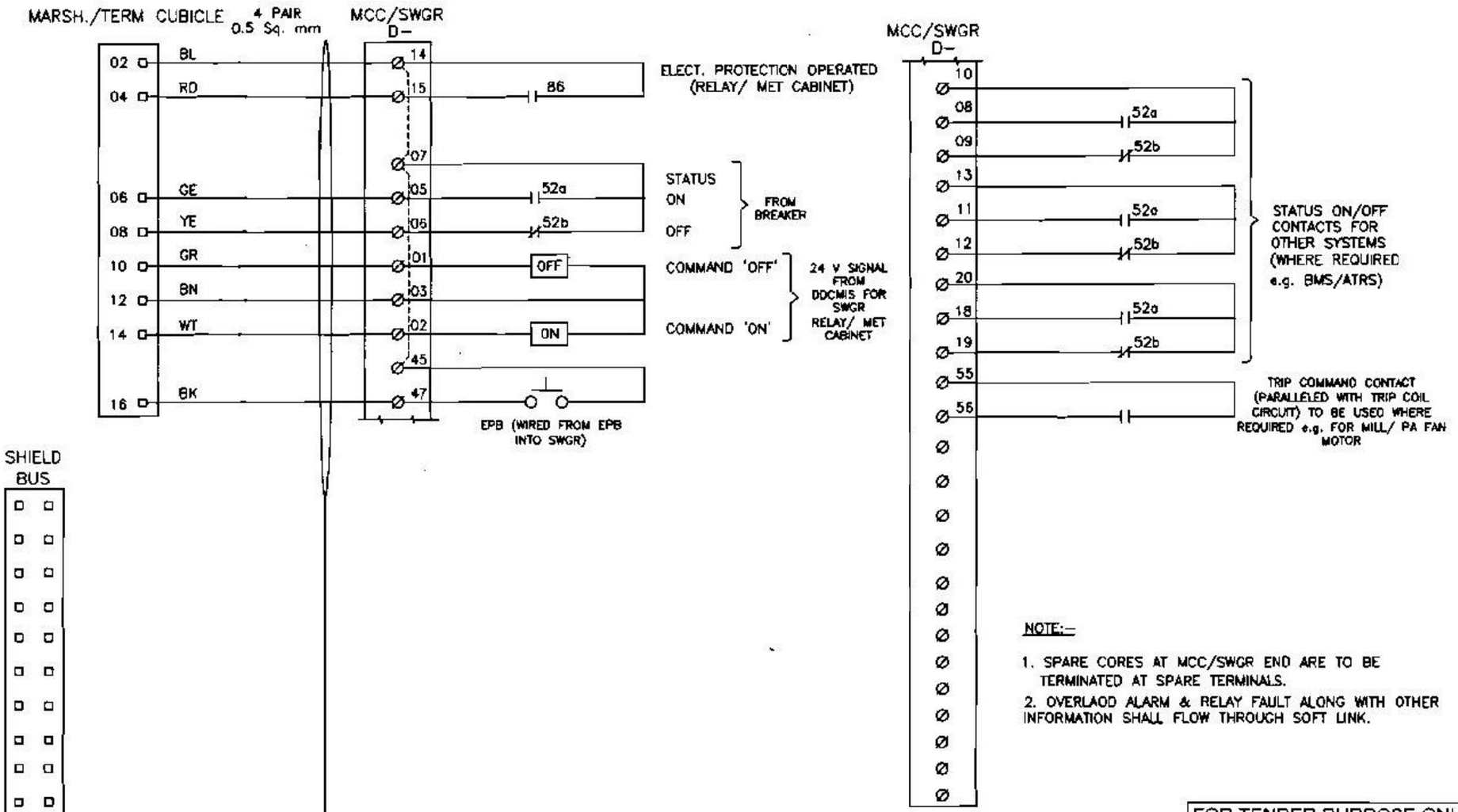
REV.NO.	DESCRIPTION	DRAWN	DESIGN	CHKD.	M	E	C	C&I	ARCH.	APPD	DATE
A	FIRST ISSUE										28.04.06

CLEARED BY

PROJECT: TYPICAL THERMAL POWER PROJECT

TITLE: INTERFACING OF FIELD INSTRUMENTS
INTERFACE OF DDCMIS WITH MCC/SWGR/ACTUATOR
(LT MOTORS)

SIZE	SCALE	DRG. NO.	REV. NO.
A3	NTS	0000-999-POI-A-065 SH 05 OF 14	A



NOTE:–

1. SPARE CORES AT MCC/SWGR END ARE TO BE TERMINATED AT SPARE TERMINALS.
2. OVERLAOD ALARM & RELAY FAULT ALONG WITH OTHER INFORMATION SHALL FLOW THROUGH SOFT LINK.

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NTPC LIMITED
(A GOVERNMENT OF INDIA ENTERPRISE)
ENGINEERING DIVISION

PROJECT: TYPICAL THERMAL POWER PROJECT

TITLE: INTERFACING OF FIELD INSTRUMENTS
INTERFACE OF DDCMIS WITH MCC/SWGR/ACTUATOR
(HT MOTORS)

REV.NO.	DESCRIPTION	DRAWN	DESIGN	CHKD.	M	C	C&I	ARCH.	APPD	DATE
B	Revised for Numerical relay based SWGR				CLEARED BY					14.02.08

SIZE	SCALE	DRG. NO.	REV. NO.
A3	NTS	0000-999-POI-A-065 SH 07 OF 14	B

ANNEXURE-I

ANNEXURE-1

Clause 9.00.00 - Specification for ULTRASONIC TYPE LEVEL TRANSMITTER:

S.No.	Features	Essential/Minimum requirement
1.	Type of Transmitter	Non contact Microprocessor based 2 wire type, HART protocol compatible Ultrasonic transmitter.
2.	Output signal	4-20 mA DC (Analog) along with superimposed digital signal (based on HART protocol)
3.	Sensor Accuracy	+/- 0.5% of calibrated span.
4.	Sensor Repeatability	3mm or better.
5.	Power supply	24 V DC +/-10%.
6.	Temperature compensation	To be provided within transducer.
7.	Configuration	
8.	Housing	Weather proof as per IP-55 with durable corrosion resistance coating.
9.	Adjustment/calibration/ maintenance	From hand held calibrators/centralized PC based system (as applicable).
10.	Zero and Span adjustment	Continuous, tamper proof, remote as well as manual to calibrate the instrument without any level in the tank/sump etc.
11.	Sensor Material	Corrosion resistant material to suit individual application requirement.
12.	False signal tolerance	Transmitter shall e capable of ignoring false echoes from internal tank/sumps obstructions such as pipes, heating coils or agitator blades. Also transmitter shall have adjustable damping circuitry.
13.	Range	Range of transmitter shall be capable of covering the complete level span of tank taking care of blocking distance, frequency attenuation due to surface, obstructions, vapors etc.

ANNEXURE-1

14.	Display	LCD display with integral keypad to be provided.
15.	Diagnostics	Loss of echo alarm etc.
16.	Load Impedance	500 ohms minimum
17.	Electrical Connection	Plug and socket
18.	Accessories	• All weather canopy for protection from direct sunlight and direct rain. • All mounting hardware and accessories required for erection and commissioning mounting fittings materials shall be SS 316. • For hazardous area, explosion proof enclosure as described in NEC article 500

Note:

1) Contractor can also provide Radar type transmitter in place of ultrasonic transmitters subject to approval by Employer during detailed Engineering. Sonic frequency based transmitters can also be provided under "ultrasonic transmitters" category for solid / viscous applications e.g. ash silo level etc.

2) The frequency used for Ultrasonic /sonic measurements shall be suitable for envisaged applications and this shall be supported by the standard product catalogue of the instrument manufacturer.

PART – B

SUB-SECTION – IIIC-07

TYPE TEST REQUIREMENTS (C&I)

CLAUSE NO.	TECHNICAL REQUIREMENTS
	TYPE TEST REQUIREMENTS (CONTROL & INSTRUMENTATION)
1.00.00	**GENERAL REQUIREMENTS**
1.01.00	The Contractor shall furnish the type test reports of all type tests as per relevant standards and codes as well as other specific tests indicated in this specification. A list of such tests are given for various equipment in table titled 'TYPE TEST REQUIREMENT FOR C&I SYSTEMS' at the end of this sub-section. For the balance equipment instrument, type tests may be conducted as per manufactures standard or if required by relevant standard. (a) Out of the tests listed, the Bidder/ sub-vendor/ manufacturer is required to conduct certain type tests specifically for this contract (and witnessed by Employer or his authorized representative) even if the same had been conducted earlier, as clearly indicated subsequently against such tests. (b) For the rest, submission of type test results and certificate shall be acceptable provided. i) The same has been carried out by the Bidder/ sub-vendor on exactly the same model /rating of equipment. ii) There has been no change in the components from the offered equipment & tested equipment. iii) The test has been carried out as per the latest standards alongwith amendments as on the date of Bid opening. (c) In case the approved equipment is different from the one on which the type test had been conducted earlier or any of the above grounds, then the tests have to be repeated and the cost of such tests shall be borne by the Bidder/ sub-vendor within the quoted price and no extra cost will be payable by the Employer on this account.
1.02.00	As mentioned against certain items, the test certificates for some of the items shall be reviewed and approved by the main Bidder or his authorized representative and the balance have to be approved by the Employer.
1.03.00	The schedule of conduction of type tests/ submission of reports shall be submitted and finalized during pre-award discussion.
1.04.00	For the type tests to be conducted, Contractor shall submit detailed test procedure for approval by Employer. This shall clearly specify test setup, instruments to be used, procedure, acceptance norms (wherever applicable), recording of different parameters, interval of recording precautions to be taken etc. for the tests to be carried out.
1.05.00	The Bidder shall indicate in the relevant Bid schedule, the cost of the type test for each item only for which type tests are to be conducted specifically for this project.

CLAUSE NO.	TECHNICAL REQUIREMENTS

The cost shall only be payable after conduction of the respective test. If a test is waived off, then the cost shall not be payable.

2.00.00 **Special Requirement for Solid State Equipments/ systems**

2.02.00 The minimum type test reports, over and above the requirements of above clause, which are to be submitted for each of the major C&I systems, various PLCs etc. shall be as indicated below:

i) Surge Protections for Solid State Equipments/ Systems

All solid state systems/ equipments shall be able to withstand the electrical noise and surges as encountered in actual service conditions and inherent in a power plant. All the solid state systems/ equipments shall be provided with all required protections that needs the surge withstand capability as defined in ANSI 37.90a/ IEEE-472. Hence, all front end cards which receive external signals like Analog input & output modules, Binary input & output modules etc. including power supply, data highway, data links shall be provided with protections that meets the surge withstand capability as defined in ANSI 37.90a/IEEE-472. Complete details of the features incorporated in electronics systems to meet this requirement, the relevant tests carried out, the test certificates etc. shall be submitted along with the proposal. As an alternative to above, suitable class of IEC-255-4 which is equivalent to ANSI 37.90a/ IEEE-472 may also be adopted for SWC test.

ii) Dry Heat test as per IEC-68-2-2 or equivalent.

iii) Damp Heat test as per IEC-68-2-3 or equivalent.

iv) Vibration test as per IEC-68-2-6 or equivalent.

v) Electrostatic discharge tests as per EN 61000-4-2 or equivalent.

vi) Radio frequency immunity test as per EN 50082-2 or equivalent.

vii) Electromagnetic immunity as per EN 61131-2 or equivalent.

Test listed at item no. (v), (vi), (vii) above are applicable for front end cards only as defined under item (i) above.

3.00.00 TYPE TEST REQUIREMENT FOR C&I SYSTEMS

Sl no	**Item**	**Test requirement**	**Standard**	**Test to be specifically conducted**	**NTPC's approval required on test certificate**
Col 1	**Col 2**	**Col 3**	**Col 4**	**Col 5**	**Col 6**
1	Narrow chart recorder	As per standard in Col 4	IS9319	No	No

CLAUSE NO.	TECHNICAL REQUIREMENTS

Sl no	Item	Test requirement	Standard	Test to be specifically conducted	NTPC's approval required on test certificate
Col 1	Col 2	Col 3	Col 4	Col 5	Col 6
2	Multi point recorder	As per standard in Col 4	IS9319	No	No
3	Vertical indicators	As per standard in Col 4	IS9319	No	No
4	Elect. Metering instruments	As per standard in Col 4	IS-1248	No	Yes
5	Thermocouple	Degree of protection test	IS-2147	No	No
6	RTD	As per standard in Col 4	IEC-751	No	No
7	C.J.C.BOX	Degree of protection test	IS-2147	No	Yes
		Ambient Temp. effect	Approved procedure	No	Yes
8	Electronic transmitter	As per standard in Col 4	BS-6447/ IEC-770	No	Yes
9	E/P converter / Smart Positioner	As per standard in Col 4	Mfr. standard	No	Yes
10	INSTRUMENTATION CABLES TWISTED & SHIELDED			No	Yes
	a) Conductor	Resistance test	VDE-0815		
		Diameter test	IS-10810		
		Tin Coating test (drain wire)			
	b) Insulation	Loss of mass	VDE 0472		
		Aging in air ovens	VDE 0472**		
		Tensile strength and elongation	VDE 0472**		
		Heat shock	VDE 0472**		
		Hot deformation	VDE 0472		
		Shrinkage	VDE 0472		
		Bleeding & blooming	IS-5831		
	c) Inner sheath	Loss of mass	VDE 0472		
		Heat shock	VDE 0472**		
		Cold bend/ cold impact test	IS-5831		
		Hot deformation	VDE 0472		
		Shrinkage	VDE 0472		
	d) Outer sheath	Loss of mass	VDE 0472		
		Aging in air ovens	VDE 0472**		

CLAUSE NO.	TECHNICAL REQUIREMENTS

Sl no	Item	Test requirement	Standard	Test to be specifically conducted	NTPC's approval required on test certificate
Col 1	Col 2	Col 3	Col 4	Col 5	Col 6
		Tensile strength and elongation test before and after ageing	VDE 0472**		
		Heat shock	VDE 0472**		
		Hot deformation	VDE 0472		
		Shrinkage	VDE 0472		
		Bleeding & blooming	IS-5831		
		Colour fastness to water	IS-5831		
		Cold bend/ cold impact test	IS-5831		
		Oxygen index test	ASTMD-2863		
		Smoke Density Test	ASTMD-2843		
		Acid gas generation test	IEC-754-1		
	e) Fillers	Oxygen index test	ASTMD-2863		
		Smoke Density Test	ASTMD-2843		
		Acid gas generation test	IEC-754-1		
	f)AL-MYLAR shield	Continuity test			
		'Shied thickness			
		Overlap test			
		Noise interference	IEEE Transactions		
	g)Over all cable	Flammability	IEEE 383		
		Noise interference			
		Dimensional checks	IS 10810		
		Cross talk			
		Mutual capacitance	VDE-0472		
		HV test	VDE-0472		
		Drain wire continuity			
11	Pressure gauge	Degree of protection test	IS-2147	No	No
		Temp interference test	IS -3624	No	No

CLAUSE NO.	TECHNICAL REQUIREMENTS

Sl no	Item	Test requirement	Standard	Test to be specifically conducted	NTPC's approval required on test certificate
Col 1	Col 2	Col 3	Col 4	Col 5	Col 6
12	Temperature gauge	Degree of protection test	IS-2147	No	No
13	Pressure & DP switch	Degree of protection test	IS-2147	No	No
		As per standard (col 4)	BS 6134	No	No
14	Level switch	Degree of protection test	IS-2147	No	No
15	Control valves	CV Test	ISA 75.02	NO	NO
16	Flow Nozzles & Orifice plate	Calibration	ASME PTC , BS 1042	No	NO
18	Junction Box	Degree of protection test	IS-2147	No	Yes

PART – B

QUALITY ASSURANCE

SUB-SECTION – IIIE-15

MEASURING INSTRUMENTS

(PRIMARY AND SECONDARY)

MEASURING INSTRUMENTS (PRIMARY AND SECONDARY)

TESTS / ITEMS	Dimensions (R)	Make, Model, Type, Rating (R)	Process / Electrical connection (R)	Calibration (R)	Test as per standard(R)	Insulation Resistance (R)	IBR Certification (if applicable)(R)	Hydro Test(R)	Material Test certificate ®
1. PR Gauge (IS-3624)	Y	Y	Y	Y	Y				
2. Temp. Gauge (BS-5235)	Y	Y	Y	Y	Y				
3. Pr./D.P.Switch(BS-6134)	Y	Y	Y	Y	Y	Y			
4. Electronic Transmitter(IEC-770)	Y	Y	Y	Y	Y	Y			
5. Temp. Switch	Y	Y	Y	Y	Y	Y			
6. Recorder(IS-9319/ANSI C-39.4)	Y	Y	Y	Y	Y	Y			
7. Vertical indicators	Y	Y	Y	Y		Y			
8. Digital Indicators	Y	Y	Y	Y		Y			
9. Integrators	Y	Y	Y	Y					
10. Electrical Metering Instrument (IS-1248)	Y	Y	Y	Y	Y	Y			
11. Transducer (IEC-688)	Y	Y	Y	Y	Y	Y			
12. Thermocouples (ANSI-MC-96.1)	Y	Y	Y	Y	Y	Y			
13. RTD(IEC-751)	Y	Y	Y	Y	Y	Y			
14. Thermowell	Y		Y				Y	Y	Y

R-Routine Test A- Acceptance Test Y – Test applicable

: Note: 1) Detailed procedure of Environmental Stress Screening shall be as per Quality Assurance Programme in General Technical Conditions

2) This is an indicative list of tests/checks. The manufacturer is to furnish a detailed quality plan indicating the Practices and Procedure adopted alongwith relevant supporting documents.

TESTS / ITEMS	Dimensions (R)	Make, Model, Type, Rating (R)	Process / Electrical connection (R)	Calibration (R)	Requirement as per standard (R)	WPS approval (A)	Non-destructive testing (R)	Calculation for accuracy (R)	Insulation Resistance (R)	IBR Certification as applicable (R)	Hydro test (R)	Material test certificate (A)
15. Cold junction compensation box	Y	Y	Y	Y					Y			
16. Orifice plate(BS-1042)	Y	Y	Y	Y *	Y	Y **	Y **			Y	Y **	Y
17. Flow nozzle(BS-1042)	Y	Y	Y	Y *	Y	Y	Y			Y	Y	Y
18. Impact head type element	Y	Y	Y					Y				Y
19. Level transmitter/float type switch	Y	Y	Y	Y					Y	Y	Y	Y
20. Flue Gas analyser	Y	Y	Y	Y								
21. Dust emission monitors	Y	Y	Y	Y								
*Calibration to be carried out on one flow element of each type and size if calibration carried out as type test same shall not be repeated.												
** If applicable												

R-Routine Test A- Acceptance Test Y – Test applicable

Note: 1) Detailed procedure of Environmental Stress screening test shall be as per Quality Assurance Programme in General Technical Conditions

2) This is an indicative list of tests/checks. The manufacturer is to furnish a detailed quality plan indicating the Practices and Procedure adopted along with relevant supporting documents.

3) APPLICABLE AS OPER SCOPE OF SUPPLY

PART – B

QUALITY ASSURANCE

SUB-SECTION – IIIE-16

PROCESS CONNECTION AND PIPING

PROCESS CONNECTION AND PIPING

TESTS / ITEMS	Visual ®	GA, BOM, Layout of component & construction feature®	Dimension ®	Paint Shade/thickness ®	Flattening,flaring,hydrotest,hardness check as per ASTM standard (A)	Component Ratings ®	Wiring ®	Make, Model, Type, Rating®	IR & HV ®	Review of TC for instrument/devices (R)	Accessability of TBs/Devices ®	Illumination,grounding ®	Tubing ®	Leak/Hydro test(A)	Chemical/physical properties of material (A)	Proof pressure test,Dismantling & reassembly test,Hydrulic impulse and vibration test (R)	Tests as per standards & specification
Local Instrument enclosure	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y			
Local instruments racks	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y			
Junction Box	Y	Y	Y	Y*		Y		Y	Y								
Gauge Board	Y	Y	Y	Y		Y		Y		Y			Y	Y			
Impulse pipes and tubes	Y		Y		Y			Y							Y		
Socket weld fittings ANSI B-16.11	Y		Y					Y							Y		Y
Compression fittings	Y		Y					Y						Y	Y	Y	
Instrument valves & Valve manifolds	Y		Y					Y						Y	Y		
Copper tubings ASTM B75	Y							Y									Y

*-applicable for painted junction boxes.
Note: R-Routine Test A- Acceptance Test Y – Test applicable
Note: This is an indicative list of tests/checks. The manufacturer is to furnish a detailed quality plan indicating the Practices and Procedure adopted alongwith relevant supporting documents.

PART – B

QUALITY ASSURANCE

SUB-SECTION – IIIE-17

INSTRUMENTATION CABLES

QUALITY ASSURANCE

INSTRUMENTATION CABLE

TESTS / ITEMS	Conductor Resistance ® & (A)	High Voltage ® & (A)	Insulation Resistance ® & (A)	Constructional detail, dimensions (A)	Outer-Sheathe/core marking, end sealing (A)	Thermal Stability (A) +	Visual, Surface finish (A) +	Electrical Parameters ** (A) +	Persulphate Test (A) +	Overall/Coverage/Continuity (A)	Swidesh chimney Test (SS-4241475) (A) ++	FRLS Test * (A) ++	Tensile & Elongation before & after aging (A) ++	Vol. Resistivity. at room & Elevated Temp. (A) ++	Spark test report review ®
1. Instrument cable twisted and shielded															
Conductor(IS-8130)	Y			Y			Y								
Insulation(VDE-207)				Y	Y	Y	Y						Y		Y
Pairing/Twisting				Y	Y		Y								
Shielding				Y			Y			Y					
Drain wire	Y			Y			Y		Y	Y					
Inner Sheath				Y	Y	Y	Y					Y	Y		
Outer Sheath				Y	Y	Y	Y					Y	Y		
Over all cable	Y	Y	Y	Y	Y		Y	Y			Y			Y	
Cable Drums(IS-10418)				Y			Y								

Note : High Temp. cables shall be subjected to tests as per VDE-207(Part-6) Compensating cables shall be checked for Thermal EMF/Endurance test as per IS 8784.

Note : This is an indicative list of tests/checks. The manufacture is to furnish a detailed Quality Plan indicating his practice & Procedure along with relevant supporting documents during QP finalization for all items.

Note : ® - Routine Test A - Acceptance Test Y - Test Applicable

Note : Sampling Plan for Acceptance test shall be as per IS 8784 (As applicable)

- * FRLS Tests: Oxygen / Temp Index (ASTM D-2863), Smoke Density Rating (ASTM – D 2843), HCL Emission (IEC-754-1)
- ** Characterisitic Impedence, Attenuation, Mutual Capacitance, Cross Talk (As applicable)

\+ Sample size will be One No. of each size/type per lot.

++ Sample size will be One No. sample for complete lot offered irrespective of size/type.

PART – B

QUALITY ASSURANCE

SUB-SECTION – IIIE-02

MOTOR

MOTOR

TESTS/CHECKS / TEMS/COMPONENTS	Visual	Dimensional	Make/Type/Rating /General Physical Inspection	Mech/Chem. Properties	NDT /DP/MPI/UT	Metallography	Electrical Characteristics	Welding/Brazing(WPS/PQR)	Heat Treatment	Magnetic Characteristics	Hydraulic/Leak/Pressure Test	Thermal Characteristics	Run out	Dynamic Balancing	Routine & Acceptance tests as per IS-325/IS-4722 /IS- 9283/IS 2148/IEC60034\IEC 60079-I/ IS-12615	vibration	Over speed	Tan delta, shaft voltage & polarization index test	Paint shade, thickness & adhesion
Plates for stator frame, end shield, spider etc.	Y	Y	Y	Y	Y				Y										
Shaft	Y	Y	Y	Y	Y	Y			Y										
Magnetic Material	Y	Y	Y	Y			Y			Y		Y							
Rotor Copper/Aluminium	Y	Y	Y	Y			Y		Y										
Stator copper	Y	Y	Y	Y			Y		Y			Y							
SC Ring	Y	Y	Y	Y	Y		Y	Y	Y										
Insulating Material	Y		Y	Y			Y					Y							
Tubes, for Cooler	Y	Y	Y	Y	Y				Y		Y								
Sleeve Bearing	Y	Y	Y	Y	Y				Y		Y								
Stator/Rotor, Exciter Coils	Y	Y	Y				Y	Y											
Castings, stator frame, terminal box and bearing housing etc.	Y	Y	Y	Y	Y			Y											
Fabrication & machining of stator, rotor, terminal box	Y	Y			Y			Y	Y										
Wound stator	Y	Y					Y	Y											
Wound Exciter	Y	Y					Y	Y											
Rotor complete	Y	Y					Y						Y	Y					

Exciter, Stator, Rotor, Terminal Box assembly	Y	Y					Y												
Accessories, RTD, BTD,CT, Space heater, antifriction bearing, gaskets etc.	Y	Y	Y																
Complete Motor	Y	Y	Y												Y	Y	Y	Y1	Y

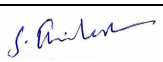
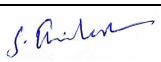
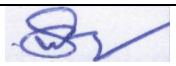
Note: 1. This is an indicative list of tests/checks. The manufacture is to furnish a detailed Quality Plan indicating the practices & Procedure followed along with relevant
supporting documents during QP finalization. However, No QP for LT motor upto 50KW.
2. Additional routine tests for Flame proof motors shall be applicable as per relevant standard
3. Makes of major bought out items for HT motors will be subject to NTPC approval.
4. Y1 = for HT Motor / Machines only.

BHARAT HEAVY ELECTRICALS LIMITED,
RANIPET- 632 406.

TECHNICAL SPECIFICATION

FOR

LT MOTORS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SPECIFICATION FOR LT MOTORS

1.0 INTENT OF SPECIFIATION

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

2.0 CODES AND STANDARDS

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

IS:325 , Three phase Induction motors
IS : 900 Code of practice for installation and maintenance of induction motors
IS: 996 , Single phase small AC and universal motors
IS: 4722 Rotating Electrical machines
IS: 4691 Degree of Protection provided by enclosures for rotating electrical machines
IS: 4728 Terminal marking and direction of rotation rotating electrical machines
IS: 1231 Dimensions of three phase foot mounted induction motors
IS: 8789 Values of performance characteristics for three phase induction motors
IS: 13555 Guide for selection and application of 3-phase A.C. induction motors for different types of driven equipment
IS: 2148 Flame proof enclosures for electrical appliance
IS: 5571 Guide for selection of electrical equipment for hazardous areas
IS: 12824 Type of duty and classes of rating assigned
IS: 12802 Temperature rise measurement of rotating electrical machines
IS: 12065 Permissible limits of noise level for rotating electrical machines
IS: 12075 Mechanical vibration of rotation of electrical machines
IS: 12615 Energy Efficient Squirrel Cage Induction Motors
IS: 3177 , Crane Duty Motors

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

3.0 DESIGN REQUIREMENTS

3.1 All LV motors shall be suitable for rated frequency of 50 Hz +3% & -5%, rated voltage of 415V, 3 Phase, or 240 V, 1 Phase with a variation of + 10% power supply. System fault level shall be 50kA for 1 Sec. Design Ambient Temperature of 50˚C and relative humidity of 95% (at 40 deg. C) shall be considered.

3.2 All the equipment, material and systems shall, in general, conform to the latest edition of relevant National and international Codes & Standards, especially the Indian Statutory Regulations

3.3 Paint shade shall be as per RAL 5012 (Blue) for indoor and outdoor equipment.

3.4 Degree of Protection

Degree of protection for various enclosures as per IS:4691, IEC60034-05 shall be as follows :-

i) Motors - IP 55

ii) Cable box - IP 55

3.5 The voltage level for motors shall be as follows:

a) Upto 0.2 KW : Single phase 240V AC / 3 phase 415V AC

b) Above 0.2 KW and upto 200 KW : 3 phase, 415V AC

c) Above 200 KW and upto 1500 KW : 3 phase, 3.3 kV AC

d) Above 1500 KW : 11 kV

3.6 Motors shall be suitable for DOL starting and shall be Premium efficiency class – IE3 conforming to IS-12615 (Latest) or IEC 60034 (Latest). Continuous duty LT motors upto 160 KW Output rating (at 50 deg.C ambient temperature), shall be **Premium Efficiency class-IE3**, conforming to IS 12615, or IEC:60034-30.

Crane duty motors shall be slip ring/ squirrel cage Induction motor as per the requirement.

Inverter duty Induction Motor with VPI insulation (Resin poor) suitable for VFD application (if fed from VFD,Variable Frequency drive). These motors shall be provided with insulated bearing on at least one side. Motor shall be suitable for operation with a solid state power supply consisting of an adjustable frequency inverter for speed control & shall be suitable for the current waveforms produced by the power supply including the harmonics generated by the drive. Motor insulation shall be designed to accept the applied voltage waveform, within the Vpeak and dv/dt limits as per IEC-61800.

Drive manufacturer shall coordinate with the motor manufacturer for proper selection of the motor for the given load application and the output characteristics of the drive.

3.7 RATING

(a) Continuously rated (S1). However, crane motors shall be rated for S4 duty, 40% cyclic duration factor.

(b) Whenever the basis for motor or driven equipment ratings are not specified in the corresponding mechanical specification sub-sections, maximum continuous motor ratings shall be at least 10% above the maximum load demand of the driven equipment under entire operating range including voltage and frequency variations.

3.8 TEMPERATURE RISE

Air cooled motors

70 deg. C by resistance method for both thermal class 130(B) & 155(F) insulation.

4.0 OPERATIONAL REQUIREMENTS

4.1 STARTING TIME

4.1.1 F**or motors with starting time upto 20 secs. at minimum permissible** voltage during starting, the locked rotor withstand time under hot **condition at highest voltage limit shall be at least 2.5 secs. more than starting time.**

4.1.2 For motors with starting time more than 20 secs. and upto 45 secs. at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at highest voltage limit shall be at least 5 secs. more than starting time.

4.1.3 For motors with starting time more than 45 secs. at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at highest voltage limit shall be more than starting time by at least 10% of the starting time.

4.1.4 Speed switches mounted on the motor shaft shall be provided in cases where above requirements are not met.

4.2 Torque Requirements

4.2.1 Accelerating torque at any speed with the lowest permissible starting voltage shall be at least 10% motor full load torque.

4.2.2 Pull out torque at rated voltage shall not be less than 205% of full load torque. It shall be 275% for crane duty motors.

4.3 Starting voltage requirement

(a) Up to 85% of rated voltage for ratings below 110 KW

(b) Up to 80% of rated voltage for ratings from 110 KW to 200 KW

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

(d) The motor shall be capable of withstanding the stresses imposed if started at 110% rated voltage.

4.4 Running Requirements

(a) Motors shall run satisfactorily at a supply voltage of 75% of rated voltage for 5 minutes with full load without injurious heating to the motor.

(b) Motor shall not stall due to voltage dip in the system causing momentary drop in voltage up to 70% of the rated voltage for duration of 2 secs.

4.5 The max. vibration velocity or double amplitude of motors vibration at motor bearings shall be within the limits specified in IS: 12075 / IEC 60034-14.

5.0 DESIGN AND CONSTRUCTIONAL FEATURES

5.1 Suitable single phase space heaters shall be provided on motors rated 30KW and above to maintain windings in dry condition when motor is standstill. Separate terminal box for space heaters & RTDs shall be provided. All motors shall be either Totally enclosed fan cooled (TEFC) or totally enclosed tube ventilated (TETV) or Closed air circuit air cooled (CACA) type.

5.2 Winding and Insulation

(a) Type : Non-hygroscopic, oil resistant, flame resistant

(b) Starting duty : Two hot starts in succession, with motor initially at normal running temperature.

5.3 The spacing between gland plate & center of terminal stud shall be as per Table-I.

5.4 All motors shall be so designed that maximum inrush currents and locked rotor and pullout torque developed by them at extreme voltage and frequency variations do not endanger the motor and driven equipment.

5.5 The motors shall be suitable for bus transfer schemes provided on the 415V systems without any injurious effect on its life.

5.6 The size and number of cables to be intimated to the successful bidder during detailed engineering and the contractor shall provide terminal box suitable for the same.

5.7 The ratio of locked rotor KVA at rated voltage to rated KW shall not exceed the following (without any further tolerance.

(a) Below 110KW : 10.0

(b) From 110 KW & upto 200 KW : 9.0

5.8 Motors shall be designed with cooling fans suitable for both directions of rotation.

5.9 Frames shall be designed to avoid collection of moisture and all enclosures shall be provided with facility for drainage at the lowest point.

5.10 In case Class 'F' insulation is provided for LV motors, temperature rise shall be limited to the limits applicable to Class 'B' insulation. In case of continuous operation at extreme voltage limits the temperature limits specified in table-1 of IS:325 shall not exceed by more than 10 deg C.

6.0 Earthing

The frame of each motor shall be provided with two separate and distinct grounding pads complete with tapped hole, GI bolts and washer. The grounding connection shall be suitable for accommodation of ground conductors as follows:

LT Motors	
a. Fractional HP	8 SWG GS wire
b. 1 to 25 KW	25 x 3 mm GS flat
c. 25 to 125 KW	25 x 6 mm GS flat
d. 125 KW and above	50 x 6 mm GS flat
Control Desks, Control/relay panels, LDBs, PDBs, Lighting Panels, Power receptacles, Lighting Masts, Lighting Poles	25 x 3 mm GS flat
LPB stations, Limit/Pressure switches, Starters, CT/PT terminal Boxes	08 SWG GI wires
Columns, structures, cable trays and bus du enclosures	50 x 6mm GS flat

The cable terminal box shall have a separate grounding pad.

7.0 Terminals and Terminal Boxes

7.1 Terminals, terminal leads, terminal boxes, windings tails and associated equipment shall be suitable for connection to a supply system having a short circuit level, specified below. Unless otherwise stated, motors of rating 110 kW and above will be controlled by circuit breaker and below 110 kW by switch fuse-contactor. The terminal box of motors shall be designed for the system fault current of 50KA (RMS) protected by fuse for 0.25 sec.

7.2 Unless otherwise specified or approved, phase terminal boxes of horizontal motors shall be positioned on the left hand side of the motor when viewed from the non-driving end.

7.3 Connections shall be such that when the supply leads R, Y & B are connected to motor terminals A B & C or U, V & W respectively, motor shall rotate in an anticlockwise direction when viewed from the non-driving end. Where such motors require clockwise rotation, the supply leads R, Y, B will be connected to motor terminals A, C, B or V W & V respectively.

7.4 Permanently attached diagram and instruction plate made preferably of stainless steel shall be mounted inside terminal box cover giving the connection diagram for the desired direction of rotation and reverse rotation.

7.5 Motor terminals and terminal leads shall be fully insulated with no bar live parts. Adequate space shall be available inside the terminal box so that no difficulty is encountered for terminating the cable.

7.6 Degree of protection for terminal boxes shall be IP 55 as per IS 4691.

7.7 Separate terminal boxes shall be provided for space heaters. If this is not possible in case of LV motors, the space heater terminals shall be adequately segregated from the main terminals in the main terminal box. Detachable gland

plates with double compression brass glands shall be provided in terminal boxes.

7.8 Phase terminal boxes shall be suitable for 360 degree of rotation in steps of 90 degree for LV motors.

7.9 Suitable Double Compression type Cable glands and cable lugs shall be provided. Cable lugs shall be of tinned Copper, crimping type. The cable sizes will be informed during detail engineering.

7.10 Two separate earthing terminals suitable for connecting G.I. or MS strip grounding conductor of size suitable for solidly grounded system shall be provided on opposite sides of motor frame. Each terminal box shall have a grounding terminal.

TABLE – I

DIMENSIONS OF TERMINAL BOXES FOR LV MOTORS

Motor MCR in KW	**Minimum distance between center of stud and gland plate in mm**
UP to 3 KW	As per manufacturer's practice.
Above 3 KW - upto 7 KW	85
Above 7 KW - upto 13 KW	115
Above 13 KW - upto 24 KW	167
Above 24 KW - upto 37 KW	196
Above 37 KW - upto 55 KW	249
Above 55 KW - upto 90 KW	277
Above 90 KW - upto 125 KW	331
Above 125 KW-upto 200 KW	203

PHASE TO PHASE/ PHASE TO EARTH AIR CLEARANCE:

NOTE: Minimum inter-phase and phase-earth air clearances for LT motors with lugs installed shall be as follows:

Motor MCR in KW	**Clearance**
UP to 110 KW	10mm
Above 110 KW and upto 150 KW	12.5mm
Above 150 KW	19mm

8.0 General

8.1 Motors provided for similar drives shall be interchangeable.
8.2 Suitable foundation bolts are to be supplied along with the motors.
8.3 Motors shall be provided with eye bolts, or other means to facilitate safe lifting if the weight is 20Kgs. and above.

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

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

9.0 INSPECTION AND TESTING

9.1 All materials, components and equipment covered under this specification shall be procured, manufactured, as per the Approved quality plan.

9.2 LT Motors supplied shall be of type tested design. During detailed engineering, the contractor shall submit for employer's approval the reports of all the type tests as listed in this specification and carried out within last ten years from the date of bid opening. These reports should be for the test conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client.

9.3 However, if the contractor is not able to submit report of the type test(s) conducted within last ten years from the date of bid opening, or in the case of type test report(s) are not found to be meeting the specification requirements, the contractor shall conduct all such tests under this contract at no additional cost to the employer either at third party lab or in presence of client/ employer's representative and submit the reports for approval.

9.4 LIST OF TESTS FOR WHICH REPORTS HAVE TO BE SUBMITTED

The following type test reports shall be submitted for each type and rating of LT motor of above 50 KW only

1. Measurement of resistance of windings of stator and wound rotor.
2. No load test at rated voltage to determine input current power and speed
3. Open circuit voltage ratio of wound rotor motors (in case of Slip ring motors)
4. Full load test to determine efficiency power factor and slip.
5. Temperature rise test.
6. Momentary excess torque test.
7. High voltage test.
8. Test for vibration severity of motor.
9. Test for noise levels of motor (Shall be limited as per clause no 7.06.00 of this section)
10. Test for degree of protection and
11. Over speed test.
12. Type test reports for motors located in fuel oil area having flame proof enclosures as per IS 2148 / IEC 60079-1

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.

The type test reports once approved for any projects shall be treated as reference. For subsequent projects of NTPC, an endorsement sheet will be furnished by the manufacturer confirming similarity and "No design Change". Minor changes if any

shall be highlighted on the endorsement sheet.

List of Quality Plan and Sub-Supplier Approval.

Si.No	Sub-Supplier	Place	Approval Status / Category	Remarks
1	CGL	AHMEDABAD	A	
2	SIEMENS	MUMBAI	A	
3	JYOTHI	BARODA	A	
4	BHARAT BIJLEE	NAVI MUMBAI	A	Upto 690 V, 500 KW for Inverter Duty & upto 415 V, 200 KW for Non-Inverter Duty
5	ABB	FARIDABAD	A	UPTO 55 KW
s6	ABB	BANGALORE	A	55 KW - 200 KW
7	NGEF	BANGALORE	A	UPTO 15 KW
8	KEC	BANGALORE	A	
9	KEC	HUBLI	A	UPTO 90 KW
10	LHP	SOLAPUR	A	UPTO 120 KW
11	MARATHON	KOLKATA	A	
12	HINDUSTAN MOTOR	MUMBAI	DR	
13	BHEL ELECTRIC MACHINES LTD	KASARGOD	DR	

LEGENDS:

A - For those items proposed Sub-vendors are acceptable to NTPC subject to meeting NTPC Technical Specification Requirement.

DR - For those items “Details Required” for NTPC review. TO be identified with letter “DR” in the list.

INSPECTION CATEGORY:

a) Less than 30 KW: Acceptance of Motor is based on COC of manufacturer & the contractor confirming as follows.
   It is hereby confirmed that the above mentioned motor/ motors was/ were manufactured taking care of NTPC specific requirements regarding ambient temp., voltage & frequency variation, hot start, out torque, starting KVA/KW, temp. rise,

distance between centre stud & gland plate and tested in accordance with approved drawing/ data sheets.

b) For 30 KW to 50 KW: Acceptance of motor rating between 30 KW & 50 KW is based on NTPC review of Routine test inspection report as per IS 325 witnessed by main contractor along with COC of manufacturer & the contractor confirming as follows:
It is hereby confirmed that the above mentioned motor/ motors was/ were manufactured taking care of NTPC specific requirements regarding ambient temp., voltage & frequency variation, hot start, out torque, starting KVA/KW, temp. rise, distance between centre stud & gland plate, space heater and tested in accordance with approved drawing/ data sheets.

c) As per NTPC approved Quality Plan (Above 50 KW)
For those items the quality plans are approved by NTPC and final acceptance will be on physical inspection witness by NTPC.

10.0 DRAWINGS TO BE SUBMITTED AFTER AWARD OF CONTRACT

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

b) Arrangement drawing of terminal boxes.

c) Characteristic curves:

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

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

iii) Torque vs. speed at rated voltage and minimum voltage.

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

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

11.0 DATA SHEET for LT MOTORS (A.C.)

A.	GENERAL	
1	Manufacturer & Country of origin. (Shall be as per approved QA make)	
2	Equipment driven by motor	

3	Motor type	
4	Quantity	
B.	**DESIGN AND PERFORMANCE DATA**	
1	Frame size	
2	Type of duty	
3	Type of enclosure /Method of cooling / Degree of protection	
4	Applicable standard to which motor generally	
5	Efficiency class as per IS 12615	
6	(a)Whether motor is flame proof	Yes/No
	(b)If yes, the gas group to which it conforms as per IS:2148	
7	Type of mounting	
8	Direction of rotation as viewed from DE END	
9	Standard continuous rating at 40 deg.C. ambient	
	temp. as per Indian Standard (KW)	
10	Derated rating for specified normal condition i.e. 50 deg. C ambient temperature (KW)	
11	Maximum continuous load demand of driven	
12	Rated Voltage (volts)	
13	Permissible variation of :	

	a. Voltage (Volts)	
	b. Frequency (Hz)	
	c. Combined voltage and frequency	
14	Rated speed at rated voltage and	
15	At rated Voltage and frequency:	
	a. Full load current	
	b. No load current	
	c. Starting Torque in % FLT	
16	Power Factor at	
	a. 100% load	
	b. NO load	
	c. Starting.	
17	Efficiency at rated voltage and frequency,	
	a.100% load	
	b. 75% load	
	c. 50% load	
18	Method of Starting	
19	Class of Insulation	

20	Stator winding connection (For cont. Run , Delta/Star)	
21	Full load torque	
22	Breakdown torque in % FLT	
23	Pull up torque in % of FLT	
24	Locked rotor current in Amps	
25	Locked rotor withstand time under hot/cold condition at 110 % Voltage	
26	Maximum permissible starting time	
27	Starting time in seconds with driven equipment coupled at 80 % voltage	
28	Actual temperature rise over an ambient of 50°C when motor is delivering rated output a) By thermometer method b) By resistance method	
29	Number of successive starts with driven equipment coupled and motor initially at rated load temperature	
30	Minimum voltage required by the motor to bring the driven equipment to rated speed	
31	Resistance per phase in ohms at 20 degree	
32	Suitable for VFD operation	Yes / No
33	Direction of rotation viewed from driving end	
34	Make, type and size of bearing a) At drive end : b) At Non drive end :	
35	Type of mounting and shaft Orientation	
36	Location of terminal box viewed from driving end	

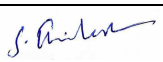
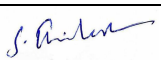
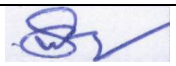
37	Type and number of terminals brought out	
38	Type and size of cable gland (size will be given during Detail engg)	
39	Cable gland entry (Top / Bottom)	
40	Tropical & fungicidal treatment	
41	GD2 of the motor	
42	Weight of the motor	

BHARAT HEAVY ELECTRICALS LIMITED,
RANIPET- 632 406.

TECHNICAL SPECIFICATION

FOR

LT MOTORS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SPECIFICATION FOR LT MOTORS

1.0 INTENT OF SPECIFIATION

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

2.0 CODES AND STANDARDS

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

IS:325 , Three phase Induction motors
IS : 900 Code of practice for installation and maintenance of induction motors
IS: 996 , Single phase small AC and universal motors
IS: 4722 Rotating Electrical machines
IS: 4691 Degree of Protection provided by enclosures for rotating electrical machines
IS: 4728 Terminal marking and direction of rotation rotating electrical machines
IS: 1231 Dimensions of three phase foot mounted induction motors
IS: 8789 Values of performance characteristics for three phase induction motors
IS: 13555 Guide for selection and application of 3-phase A.C. induction motors for different types of driven equipment
IS: 2148 Flame proof enclosures for electrical appliance
IS: 5571 Guide for selection of electrical equipment for hazardous areas
IS: 12824 Type of duty and classes of rating assigned
IS: 12802 Temperature rise measurement of rotating electrical machines
IS: 12065 Permissible limits of noise level for rotating electrical machines
IS: 12075 Mechanical vibration of rotation of electrical machines
IS: 12615 Energy Efficient Squirrel Cage Induction Motors
IS: 3177 , Crane Duty Motors

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

3.0 DESIGN REQUIREMENTS

3.1 All LV motors shall be suitable for rated frequency of 50 Hz +3% & -5%, rated voltage of 415V, 3 Phase, or 240 V, 1 Phase with a variation of + 10% power supply. System fault level shall be 50kA for 1 Sec. Design Ambient Temperature of 50˚C and relative humidity of 95% (at 40 deg. C) shall be considered.

3.2 All the equipment, material and systems shall, in general, conform to the latest edition of relevant National and international Codes & Standards, especially the Indian Statutory Regulations

3.3 Paint shade shall be as per RAL 5012 (Blue) for indoor and outdoor equipment.

3.4 Degree of Protection

Degree of protection for various enclosures as per IS:4691, IEC60034-05 shall be as follows :-

i) Motors - IP 55

ii) Cable box - IP 55

3.5 The voltage level for motors shall be as follows:

a) Upto 0.2 KW : Single phase 240V AC / 3 phase 415V AC

b) Above 0.2 KW and upto 200 KW : 3 phase, 415V AC

c) Above 200 KW and upto 1500 KW : 3 phase, 3.3 kV AC

d) Above 1500 KW : 11 kV

3.6 Motors shall be suitable for DOL starting and shall be Premium efficiency class – IE3 conforming to IS-12615 (Latest) or IEC 60034 (Latest). Continuous duty LT motors upto 160 KW Output rating (at 50 deg.C ambient temperature), shall be **Premium Efficiency class-IE3**, conforming to IS 12615, or IEC:60034-30.

Crane duty motors shall be slip ring/ squirrel cage Induction motor as per the requirement.

Inverter duty Induction Motor with VPI insulation (Resin poor) suitable for VFD application (if fed from VFD,Variable Frequency drive). These motors shall be provided with insulated bearing on at least one side. Motor shall be suitable for operation with a solid state power supply consisting of an adjustable frequency inverter for speed control & shall be suitable for the current waveforms produced by the power supply including the harmonics generated by the drive. Motor insulation shall be designed to accept the applied voltage waveform, within the Vpeak and dv/dt limits as per IEC-61800.

Drive manufacturer shall coordinate with the motor manufacturer for proper selection of the motor for the given load application and the output characteristics of the drive.

3.7 RATING

(a) Continuously rated (S1). However, crane motors shall be rated for S4 duty, 40% cyclic duration factor.

(b) Whenever the basis for motor or driven equipment ratings are not specified in the corresponding mechanical specification sub-sections, maximum continuous motor ratings shall be at least 10% above the maximum load demand of the driven equipment under entire operating range including voltage and frequency variations.

3.8 TEMPERATURE RISE

Air cooled motors

70 deg. C by resistance method for both thermal class 130(B) & 155(F) insulation.

4.0 OPERATIONAL REQUIREMENTS

4.1 STARTING TIME

4.1.1 F**or motors with starting time upto 20 secs. at minimum permissible** voltage during starting, the locked rotor withstand time under hot **condition at highest voltage limit shall be at least 2.5 secs. more than starting time.**

4.1.2 For motors with starting time more than 20 secs. and upto 45 secs. at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at highest voltage limit shall be at least 5 secs. more than starting time.

4.1.3 For motors with starting time more than 45 secs. at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at highest voltage limit shall be more than starting time by at least 10% of the starting time.

4.1.4 Speed switches mounted on the motor shaft shall be provided in cases where above requirements are not met.

4.2 Torque Requirements

4.2.1 Accelerating torque at any speed with the lowest permissible starting voltage shall be at least 10% motor full load torque.

4.2.2 Pull out torque at rated voltage shall not be less than 205% of full load torque. It shall be 275% for crane duty motors.

4.3 Starting voltage requirement

(a) Up to 85% of rated voltage for ratings below 110 KW

(b) Up to 80% of rated voltage for ratings from 110 KW to 200 KW

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

(d) The motor shall be capable of withstanding the stresses imposed if started at 110% rated voltage.

4.4 Running Requirements

(a) Motors shall run satisfactorily at a supply voltage of 75% of rated voltage for 5 minutes with full load without injurious heating to the motor.

(b) Motor shall not stall due to voltage dip in the system causing momentary drop in voltage up to 70% of the rated voltage for duration of 2 secs.

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(a) Type : Non-hygroscopic, oil resistant, flame resistant

(b) Starting duty : Two hot starts in succession, with motor initially at normal running temperature.

5.3 The spacing between gland plate & center of terminal stud shall be as per Table-I.

5.4 All motors shall be so designed that maximum inrush currents and locked rotor and pullout torque developed by them at extreme voltage and frequency variations do not endanger the motor and driven equipment.

5.5 The motors shall be suitable for bus transfer schemes provided on the 415V systems without any injurious effect on its life.

5.6 The size and number of cables to be intimated to the successful bidder during detailed engineering and the contractor shall provide terminal box suitable for the same.

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5.9 Frames shall be designed to avoid collection of moisture and all enclosures shall be provided with facility for drainage at the lowest point.

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6.0 Earthing

The frame of each motor shall be provided with two separate and distinct grounding pads complete with tapped hole, GI bolts and washer. The grounding connection shall be suitable for accommodation of ground conductors as follows:

LT Motors	
a. Fractional HP	8 SWG GS wire
b. 1 to 25 KW	25 x 3 mm GS flat
c. 25 to 125 KW	25 x 6 mm GS flat
d. 125 KW and above	50 x 6 mm GS flat
Control Desks, Control/relay panels, LDBs, PDBs, Lighting Panels, Power receptacles, Lighting Masts, Lighting Poles	25 x 3 mm GS flat
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7.3 Connections shall be such that when the supply leads R, Y & B are connected to motor terminals A B & C or U, V & W respectively, motor shall rotate in an anticlockwise direction when viewed from the non-driving end. Where such motors require clockwise rotation, the supply leads R, Y, B will be connected to motor terminals A, C, B or V W & V respectively.

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plates with double compression brass glands shall be provided in terminal boxes.

7.8 Phase terminal boxes shall be suitable for 360 degree of rotation in steps of 90 degree for LV motors.

7.9 Suitable Double Compression type Cable glands and cable lugs shall be provided. Cable lugs shall be of tinned Copper, crimping type. The cable sizes will be informed during detail engineering.

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9.1 All materials, components and equipment covered under this specification shall be procured, manufactured, as per the Approved quality plan.

9.2 LT Motors supplied shall be of type tested design. During detailed engineering, the contractor shall submit for employer's approval the reports of all the type tests as listed in this specification and carried out within last ten years from the date of bid opening. These reports should be for the test conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client.

9.3 However, if the contractor is not able to submit report of the type test(s) conducted within last ten years from the date of bid opening, or in the case of type test report(s) are not found to be meeting the specification requirements, the contractor shall conduct all such tests under this contract at no additional cost to the employer either at third party lab or in presence of client/ employer's representative and submit the reports for approval.

9.4 LIST OF TESTS FOR WHICH REPORTS HAVE TO BE SUBMITTED

The following type test reports shall be submitted for each type and rating of LT motor of above 50 KW only

1. Measurement of resistance of windings of stator and wound rotor.
2. No load test at rated voltage to determine input current power and speed
3. Open circuit voltage ratio of wound rotor motors (in case of Slip ring motors)
4. Full load test to determine efficiency power factor and slip.
5. Temperature rise test.
6. Momentary excess torque test.
7. High voltage test.
8. Test for vibration severity of motor.
9. Test for noise levels of motor (Shall be limited as per clause no 7.06.00 of this section)
10. Test for degree of protection and
11. Over speed test.
12. Type test reports for motors located in fuel oil area having flame proof enclosures as per IS 2148 / IEC 60079-1

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.

The type test reports once approved for any projects shall be treated as reference. For subsequent projects of NTPC, an endorsement sheet will be furnished by the manufacturer confirming similarity and "No design Change". Minor changes if any

shall be highlighted on the endorsement sheet.

List of Quality Plan and Sub-Supplier Approval.

Si.No	Sub-Supplier	Place	Approval Status / Category	Remarks
1	CGL	AHMEDABAD	A	
2	SIEMENS	MUMBAI	A	
3	JYOTHI	BARODA	A	
4	BHARAT BIJLEE	NAVI MUMBAI	A	Upto 690 V, 500 KW for Inverter Duty & upto 415 V, 200 KW for Non-Inverter Duty
5	ABB	FARIDABAD	A	UPTO 55 KW
s6	ABB	BANGALORE	A	55 KW - 200 KW
7	NGEF	BANGALORE	A	UPTO 15 KW
8	KEC	BANGALORE	A	
9	KEC	HUBLI	A	UPTO 90 KW
10	LHP	SOLAPUR	A	UPTO 120 KW
11	MARATHON	KOLKATA	A	
12	HINDUSTAN MOTOR	MUMBAI	DR	
13	BHEL ELECTRIC MACHINES LTD	KASARGOD	DR	

LEGENDS:

A - For those items proposed Sub-vendors are acceptable to NTPC subject to meeting NTPC Technical Specification Requirement.

DR - For those items “Details Required” for NTPC review. TO be identified with letter “DR” in the list.

INSPECTION CATEGORY:

a) Less than 30 KW: Acceptance of Motor is based on COC of manufacturer & the contractor confirming as follows.
   It is hereby confirmed that the above mentioned motor/ motors was/ were manufactured taking care of NTPC specific requirements regarding ambient temp., voltage & frequency variation, hot start, out torque, starting KVA/KW, temp. rise,

distance between centre stud & gland plate and tested in accordance with approved drawing/ data sheets.

b) For 30 KW to 50 KW: Acceptance of motor rating between 30 KW & 50 KW is based on NTPC review of Routine test inspection report as per IS 325 witnessed by main contractor along with COC of manufacturer & the contractor confirming as follows:
It is hereby confirmed that the above mentioned motor/ motors was/ were manufactured taking care of NTPC specific requirements regarding ambient temp., voltage & frequency variation, hot start, out torque, starting KVA/KW, temp. rise, distance between centre stud & gland plate, space heater and tested in accordance with approved drawing/ data sheets.

c) As per NTPC approved Quality Plan (Above 50 KW)
For those items the quality plans are approved by NTPC and final acceptance will be on physical inspection witness by NTPC.

10.0 DRAWINGS TO BE SUBMITTED AFTER AWARD OF CONTRACT

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

b) Arrangement drawing of terminal boxes.

c) Characteristic curves:

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

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

iii) Torque vs. speed at rated voltage and minimum voltage.

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

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

11.0 DATA SHEET for LT MOTORS (A.C.)

A.	GENERAL	
1	Manufacturer & Country of origin. (Shall be as per approved QA make)	
2	Equipment driven by motor	

3	Motor type	
4	Quantity	
B.	**DESIGN AND PERFORMANCE DATA**	
1	Frame size	
2	Type of duty	
3	Type of enclosure /Method of cooling / Degree of protection	
4	Applicable standard to which motor generally	
5	Efficiency class as per IS 12615	
6	(a)Whether motor is flame proof	Yes/No
	(b)If yes, the gas group to which it conforms as per IS:2148	
7	Type of mounting	
8	Direction of rotation as viewed from DE END	
9	Standard continuous rating at 40 deg.C. ambient	
	temp. as per Indian Standard (KW)	
10	Derated rating for specified normal condition i.e. 50 deg. C ambient temperature (KW)	
11	Maximum continuous load demand of driven	
12	Rated Voltage (volts)	
13	Permissible variation of :	

	a. Voltage (Volts)	
	b. Frequency (Hz)	
	c. Combined voltage and frequency	
14	Rated speed at rated voltage and	
15	At rated Voltage and frequency:	
	a. Full load current	
	b. No load current	
	c. Starting Torque in % FLT	
16	Power Factor at	
	a. 100% load	
	b. NO load	
	c. Starting.	
17	Efficiency at rated voltage and frequency,	
	a.100% load	
	b. 75% load	
	c. 50% load	
18	Method of Starting	
19	Class of Insulation	

20	Stator winding connection (For cont. Run , Delta/Star)	
21	Full load torque	
22	Breakdown torque in % FLT	
23	Pull up torque in % of FLT	
24	Locked rotor current in Amps	
25	Locked rotor withstand time under hot/cold condition at 110 % Voltage	
26	Maximum permissible starting time	
27	Starting time in seconds with driven equipment coupled at 80 % voltage	
28	Actual temperature rise over an ambient of 50°C when motor is delivering rated output a) By thermometer method b) By resistance method	
29	Number of successive starts with driven equipment coupled and motor initially at rated load temperature	
30	Minimum voltage required by the motor to bring the driven equipment to rated speed	
31	Resistance per phase in ohms at 20 degree	
32	Suitable for VFD operation	Yes / No
33	Direction of rotation viewed from driving end	
34	Make, type and size of bearing a) At drive end : b) At Non drive end :	
35	Type of mounting and shaft Orientation	
36	Location of terminal box viewed from driving end	

37	Type and number of terminals brought out	
38	Type and size of cable gland (size will be given during Detail engg)	
39	Cable gland entry (Top / Bottom)	
40	Tropical & fungicidal treatment	
41	GD2 of the motor	
42	Weight of the motor	

PART – B

SUB-SECTION – IIIB-01

MOTORS

CLAUSE NO.	TECHNICAL REQUIREMENTS

MOTORS

1.00.00 GENERAL REQUIREMENTS

1.01.00 For the purpose of design of equipment/systems, an ambient temperature of 50 deg. Centigrade and relative humidity of 95% (at 40 deg C) shall be considered. The equipment shall operate in a highly polluted environment.

1.02.00 All equipments shall be suitable for rated frequency of 50 Hz with a variation of +3% & -5%, and 10% combined variation of voltage and frequency unless specifically brought out in the specification.

1.03.00 Contractor shall provide fully compatible electrical system, equipments, accessories and services.

1.04.00 All the equipment, material and systems shall, in general, conform to the latest edition of relevant National and international Codes & Standards, especially the Indian Statutory Regulations.

1.05.00 Paint shade shall be as per RAL 5012 (Blue) for indoor and outdoor equipment.

1.06.00 The responsibility of coordination with electrical agencies and obtaining all necessary clearances for contractors equipment and systems shall be under the contractor scope.

1.07.00 Degree of Protection

Degree of protection for various enclosures as per IS:4691, IEC60034-05 shall be as follows :-

i)	Indoor motors	-	IP 54
ii)	Outdoor motors	-	IP 55
iii)	Cable box-indoor area	-	IP 54
iv)	Cable box-Outdoor area	-	IP 55

1.08.00 The voltage level for motors shall be as follows :-

Upto 0.2KW	:	240V, Single Phase AC/ 415V, Three Phase AC
Above 0.2 and upto 200 KW	:	415V, Three Phase AC
Above 200KW & upto 1500KW	:	3.3 kV, Three Phase AC
Above 1500kW	:	11 kV, Three Phase AC

Voltage ratings for all the submersible pump motors shall be on 415V only.

CLAUSE NO.	TECHNICAL REQUIREMENTS
2.00.00	**CODES AND STANDARDS** 1) Three phase induction motors : IS:325, IEC:60034 2) Single phase AC motors : IS:996, IEC:60034 3) Crane duty motors : IS:3177, IEC:60034 4) DC motors/generators : IS:4722, IEC:60034 5) Energy Efficient motors : IS 12615, IEC:60034-30
3.00.00	**TYPE**
3.01.00	**AC Motors:** a) Squirrel cage induction motor suitable for direct-on-line starting. b) Continuous duty LT motors upto 160 KW Output rating (at 50 deg.C ambient temperature), shall be **Premium Efficiency class-IE3**, conforming to IS 12615, or IEC:60034-30. c) Crane duty motors shall be slip ring/ squirrel cage Induction motor as per the requirement.
3.02.00	DC Motors Shunt wound.
4.00.00	**RATING** (a) Continuously rated (S1). However, crane motors shall be rated for S4 duty, 40% cyclic duration factor. (b) Whenever the basis for motor or driven equipment ratings are not specified in the corresponding mechanical specification sub-sections, maximum continuous motor ratings shall be at least 10% above the maximum load demand of the driven equipment under entire operating range including voltage and frequency variations. (c) For BFP motors starting MVA shall be restricted to 60 MVA.
5.00.00	**TEMPERATURE RISE** **Air cooled motors** 70 deg. C by resistance method for both thermal class 130(B) & 155(F) insulation. **Water cooled**

CLAUSE NO.	TECHNICAL REQUIREMENTS
	80 deg. C over inlet cooling water temperature mentioned elsewhere, by resistance method for both thermal class 130(B) & 155(F) insulation.
6.00.00	**OPERATIONAL REQUIREMENTS**
6.01.00	**Starting Time**
6.01.01	For motors with starting time upto 20 secs. at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at highest voltage limit shall be at least 2.5 secs. more than starting time.
6.01.02	For motors with starting time more than 20 secs. and upto 45 secs. at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at highest voltage limit shall be at least 5 secs. more than starting time.
6.01.03	For motors with starting time more than 45 secs. at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at highest voltage limit shall be more than starting time by at least 10% of the starting time.
6.01.04	Speed switches mounted on the motor shaft shall be provided in cases where above requirements are not met.
6.02.00	**Torque Requirements**
6.02.01	Accelerating torque at any speed with the lowest permissible starting voltage shall be at least 10% motor full load torque.
6.02.02	Pull out torque at rated voltage shall not be less than 205% of full load torque. It shall be 275% for crane duty motors.
6.03.00	**Starting voltage requirement** (a) Up to 85% of rated voltage for ratings below 110 KW (b) Up to 80% of rated voltage for ratings from 110 KW to 200 KW (c) Up to 85% of rated voltage for ratings from 201 KW to 1000 KW (d) Up to 80% of rated voltage for ratings from 1001 KW to 4000 KW (e) Up to 75 % of rated voltage for ratings above 4000KW Except AOP & JOP motors running on D.G emergency supply, starting voltage shall be 80%.
7.00.00	**DESIGN AND CONSTRUCTIONAL FEATURES**
7.01.00	Suitable single phase space heaters shall be provided on motors rated 30KW and above to maintain windings in dry condition when motor is standstill. Separate terminal box for space heaters & RTDs shall be provided. However for flame proof motors, space heater terminals inside the main terminal box may be acceptable.

CLAUSE NO.	TECHNICAL REQUIREMENTS
7.02.00	All motors shall be either Totally enclosed fan cooled (TEFC) or totally enclosed tube ventilated (TETV) or Closed air circuit air cooled (CACA) type. However, motors rated 3000KW or above can be Closed air circuit water cooled (CACW). CW motors can be screen protected drip proof (SPDP) type. Motors and EPB located in hazardous areas shall have flame proof enclosures conforming to IS:2148 as detailed below (a) Fuel oil area : Group – IIB (b) Hydrogen generation :Group - IIC or (Group-I, Div-II as per plant area NEC) or (Class-1, Group-B, Div-II as per NEMA /IEC60034)
7.03.00	Winding and Insulation (a) Type : Non-hygroscopic, oil resistant, flame resistant (b) Starting duty : Two hot starts in succession, with motor initially at normal running temperature. (c) 11kV & 3.3 kV AC motors : Thermal class 155 (F) insulation. The winding insulation process shall be total Vacuum Presure Impregnated i.e resin poor method. The lightning Impulse & interturn insulation surge withstand level shall be as per IEC-60034 part-15. (d) 240VAC, 415V AC & 220V DC motors : Thermal Class (B) or better
7.04.00	Motors rated above 1000KW shall have insulated bearings to prevent flow of shaft currents.
7.05.00	Motors with heat exchangers shall have dial type thermometer with adjustable alarm contacts to indicate inlet and outlet primary air temperature.
7.06.00	Noise level for all the motors shall be limited to 85dB(A) except for BFP motor for which the maximum limit shall be 90dB(A). Vibration shall be limited within the limits prescribed in IS:12075 / IEC 60034-14 . Motors shall withstand vibrations produced by driven equipment. HT motor bearing housings shall have flat surfaces, in both X and Y directions, suitable for mounting 80mmX80mm vibration pads.
7.07.00	In HT motors, at least four numbers simplex / two numbers duplex platinum resistance type temperature detectors shall be provided in each phase stator winding. Each bearing of HT motor shall be provided with dial type thermometer with adjustable alarm contact and preferably 2 numbers duplex platinum resistance type temperature detectors.

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7.08.00	Motor body shall have two earthing points on opposite sides.
7.09.00	11 KV motors shall be offered with Separate Insulated Connector (Elastimould or Equivalent make) as per IEEE 386. The offered elastimould terminations shall be provided with protective cover and trifurcating sleeves. Elastimould termination kit shall be suitable for fault level of 25 KA for 0.17 seconds.
7.10.00	3.3 KV motors shall be offered with dust tight phase separated double walled (metallic as well as insulated barrier) Terminal box. Suitable termination kit shall be provided for the offered Terminal box. The offered Terminal Box shall be suitable for fault level of 250 MVA for 0.12 sec. Removable gland plates of thickness 3 mm (hot/cold rolled sheet steel) or 4 mm (non magnetic material for single core cables) shall be provided.
7.11.00	The spacing between gland plate & centre of terminal stud shall be as per Table-I.
7.12.00	All motors shall be so designed that maximum inrush currents and locked rotor and pullout torque developed by them at extreme voltage and frequency variations do not endanger the motor and driven equipment.
7.13.00	The motors shall be suitable for bus transfer schemes provided on the 11kV, 3.3 kV /415V systems without any injurious effect on its life.
7.14.00	For motors rated 2000 KW & above, neutral current transformers of PS class shall be provided on each phase in a separate neutral terminal box.
7.15.00	The size and number of cables (for HT and LT motors) to be intimated to the successful bidder during detailed engineering and the contractor shall provide terminal box suitable for the same.
8.00.00	The ratio of locked rotor KVA at rated voltage to rated KW shall not exceed the following (without any further tolerance) except for BFP motor. (a) Below 110KW : 10.0 (b) From 110 KW & upto 200 KW : 9.0 (c) Above 200 KW & upto 1000KW : 10.0 (d) From 1001KW & upto 4000KW : 9.0 (e) Above 4000KW : 6 to 6.5
10.00.00	**TYPE TEST**
10.01.00	**HT MOTORS**
10.01.01	The contractor shall carry out the type tests as listed in this specification on the equipment to be supplied under this contract. The bidder shall indicate the charges for each of these type tests separately in the relevant schedule of Section - VII- (BPS) and the same shall be considered for the evaluation of the bids. The

CLAUSE NO.	TECHNICAL REQUIREMENTS
	type tests charges shall be paid only for the test(s) actually conducted successfully under this contract and upon certification by the employer's engineer.
10.01.02	The type tests shall be carried out in presence of the employer's representative, for which minimum 15 days notice shall be given by the contractor. The contractor shall obtain the employer's approval for the type test procedure before conducting the type test. The type test procedure shall clearly specify the test set–up, instruments to be used, procedure, acceptance norms, recording of different parameters, interval of recording, precautions to be taken etc. for the type test(s) to be carried out.
10.01.03	In case the contractor has conducted such specified type test(s) within last ten years as on the date of bid opening, he may submit during detailed engineering the type test reports to the employer for waival of conductance of such test(s). These reports should be for the tests conducted on the equipment similar to those proposed to be supplied under this contract and test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client. The employer reserves the right to waive conducting of any or all the specified type test(s) under this contract. In case type tests are waived, the type test charges shall not be payable to the contractor.
10.01.04	Further the Contractor shall only submit the reports of the type tests as listed in "LIST OF TESTS FOR WHICH REPORTS HAVE TO BE SUBMITTED "and carried out within last ten years from the date of bid opening. These reports should be for the test conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client. However if the contractor is not able to submit report of the type test(s) conducted within last ten years from the date of bid opening, or in the case of type test report(s) are not found to be meeting the specification requirements, the contractor shall conduct all such tests under this contract at no additional cost to the employer either at third party lab or in presence of client/ employer's representative and submit the reports for approval.
10.01.05	**LIST OF TYPE TESTS TO BE CONDUCTED** **The following type tests shall be conducted on each type and rating of HT motor** (a) No load saturation and loss curves upto approximately 115% of rated voltage (b) Measurement of noise at no load. (c) Momentary excess torque test (subject to test bed constraint). (d) Full load test (subject to test bed constraint) (e) Temperature rise test at rated conditions. During heat run test, bearing temp., winding temp.,coolant flow and its temp. shall also be measured. In

CLAUSE NO.	TECHNICAL REQUIREMENTS
	case the temperature rise test is carried at load other than rated load, specific approval for the test method and procedure is required to be obtained. Wherever ETD's are provided, the temperature shall be measured by ETD's also for the record purpose.
10.01.06	**LIST OF TESTS FOR WHICH REPORTS HAVE TO BE SUBMITTED** The following type test reports shall be submitted for each type and rating of HT motor (a) Degree of protection test for the enclosure followed by IR, HV and no load run test. (b) Terminal box-fault level withstand test for each type of terminal box of HT motors only. (c) Lightning Impulse withstand test on the sample coil shall be as per clause no. 4.3 IEC-60034, part-15 (d) Surge-withstand test on interturn insulation shall be as per clause no. 4.2 of IEC 60034, part-15
10.02.00	**LT Motors**
10.02.01	LT Motors supplied shall be of type tested design. During detailed engineering, the contractor shall submit for employer's approval the reports of all the type tests as listed in this specification and carried out within last *ten* years from the date of bid opening. These reports should be for the test conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client.
10.02.02	However if the contractor is not able to submit report of the type test(s) conducted within last ten years from the date of bid opening, or in the case of type test report(s) are not found to be meeting the specification requirements, the contractor shall conduct all such tests under this contract at no additional cost to the employer either at third party lab or in presence of client/ employer's representative and submit the reports for approval.
10.02.03	**LIST OF TESTS FOR WHICH REPORTS HAVE TO BE SUBMITTED** **The following type test reports shall be submitted for each type and rating of LT motor of above 50 KW only** 1. Measurement of resistance of windings of stator and wound rotor. 2. No load test at rated voltage to determine input current power and speed

CLAUSE NO.	TECHNICAL REQUIREMENTS
	3. Open circuit voltage ratio of wound rotor motors (in case of Slip ring motors) 4. Full load test to determine efficiency power factor and slip. 5. Temperature rise test. 6. Momentary excess torque test. 7. High voltage test. 8. Test for vibration severity of motor. 9. Test for noise levels of motor(Shall be limited as per clause no 7.06.00 of this section) 10. Test for degree of protection and 11. Overspeed test. 12. Type test reports for motors located in fuel oil area having flame proof enclosures as per IS 2148 / IEC 60079-1
10.03.00	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.
10.04.00	The type test reports once approved for any projects shall be treated as reference. For subsequent projects of NTPC, an endorsement sheet will be furnished by the manufacturer confirming similarity and “No design Change”. Minor changes if any shall be highlighted on the endorsement sheet.

CLAUSE NO.	TECHNICAL REQUIREMENTS

TABLE - I

DIMENSIONS OF TERMINAL BOXES FOR LV MOTORS

Motor MCR in KW of	**Minimum distance between centre stud and gland plate in mm**
UP to 3 KW	**As per manufacturer's practice.**
Above 3 KW - upto 7 KW	85
Above 7 KW - upto 13 KW	115
Above 13 KW - upto 24 KW	167
Above 24 KW - upto 37 KW	196
Above 37 KW - upto 55 KW	249
Above 55 KW - upto 90 KW	277
Above 90 KW - upto 125 KW	331
Above 125 KW-upto 200 KW	203

For HT motors the distance between gland plate and the terminal studs shall not be less than 500 mm.

PHASE TO PHASE/ PHASE TO EARTH AIR CLEARANCE:

NOTE: Minimum inter-phase and phase-earth air clearances for LT motors with lugs installed shall be as follows:

Motor MCR in KW	**Clearance**
UP to 110 KW	10mm
Above 110 KW and upto 150 KW	12.5mm
Above 150 KW	19mm

PART – B

SUB-SECTION – IIIC-01

BASIC DESIGN CRETERIA

CLAUSE NO.	TECHNICAL REQUIREMENTS
	BASIC DESIGN CRITERIA
1.00.00	**GENERAL REQUIREMENTS**
1.01.00	The Bidder shall provide Independent Control & Instrumentation system for control, monitoring and operation of associated drives and auxiliaries in all regimes of operation in safe and most efficient manner including Auxiliary Plant Control system associated Primary and Secondary Instruments, Panels / Desks. Process Connection and Piping, charges & batteries, associated Instrumentation Cables etc. as identified in the specification.
1.02.00	The Bidder shall provide all material, equipment and services so as to make a totally integrated Instrumentation and Control System together with all accessories, auxiliaries and associated equipment 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.
1.03.00	Further, Bidder shall also include in his proposal and 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 Bidder and for meeting the intent and requirements of the specification.
1.04.00	It is to be noted that where equipment or system for the generating units are described, it shall be understood that the quantities described are to be provided per unit basis, i.e., identical sets to be furnished by the Bidder for each of the units unless specifically indicated otherwise. Where equipment or systems for plant common facilities are described, it will be understood that the quantities described are the total quantities required. Wherever quantity has been specified as on as required basis, the same is to be supplied by the Bidder on as required basis by the Bidder within his quoted lump sum price.
1.05.00	Bidder shall include in his bid a detailed Bill of Material (BOM) for each of the systems.
1.06.00	In addition to requirements specified under this Section-VI, Part-B, all C&I systems/ sub-systems/ equipment/ devices shall also meet other requirements stipulated under other Sub-sections/ parts/ sections of specification.
2.00.00	**RELIABILITY AND AVAILABILITY**
2.01.00	Each component and system offered by the Bidder shall be of established reliability. The minimum target reliability of each piece of equipment like each electronic module/card, Power supply, Peripheral etc. shall be established by the Bidder, considering its failure rate/mean time between failures (MTBF), meantime to repair (MTTR), such that the availability of the complete C&I system is assured.
2.02.00	When more than one device uses the same measurement or control signal, the transmitter and other components/ module shall be fully equipped to provide all signal requirements. All the 4-20 mA output signals from transmitters/other control system shall be able to drive minimum 500 Ohms load resistance. The system shall be arranged so that the failure of any monitoring device or control components or

CLAUSE NO.	TECHNICAL REQUIREMENTS
	spurious intermediate grounding in the signal path shall not open the signal loop nor cause the loss or malfunction of signal to other devices using the same signal.
2.03.00	To ensure availability, adequate redundancy in system design shall be provided at hardware, software and sensor level to satisfy the availability criteria mentioned above. For the protection system, independent sensing device shall be provided to ensure adequate safety of plant equipment.
3.00.00	**OPERABILITY & MAINTAINABILITY**
3.01.00	The design of the control and instrumentation related equipment shall adhere to the principle of 'Fail Safe' Operation wherever safety of personnel / plant equipment is involved. 'Fail Safe' operation signifies that the loss of excitation or failure of any component shall not cause a hazardous condition. The types of failure that shall be taken into account for ensuring operability of the plant shall include but not be limited to: — Failure of sensor or transmitter. — Loss of motive power to final control element. — Loss of instrument air.
3.02.00	The choice of hardware shall also take into account sound maintainability principles and techniques. The same shall include but shall not be limited to the following: — Standardization of parts. — Minimum use of special tools. — Grouping of functions. — Interchangeability. — Malfunction identification facility/self surveillance facility. — Easy modular replacement. — Fool proof design providing proper identification and other features to preclude improper mounting and installation. — Appropriate de-rating of electronic components and parts.
3.02.00	The equipment shall employ latest state of the art technology to guard against obsolescence. In any case, Bidder shall be required to ensure supply of spare parts for lifetime of the plant. In case, the Bidder feels that certain equipment/component is likely to become obsolete, the Bidder shall clearly bring out the same in his Bid and indicate steps proposed to deal with such obsolescence.
4.00.00	**ENVIRONMENTAL CONDITIONS**
	Instruments, devices and equipment for location in outdoors/indoor/air-conditioned areas shall be designed to suit the environmental conditions indicated below and shall be suitable for continuous operation in the operating environment of a coal fired

CLAUSE NO.	TECHNICAL REQUIREMENTS

utility station and also during periods of air conditioning failure without any loss of function, or departure from the specification requirements covered under this specification.

Ambient Temperature (outside cabinets)	Pressure	Relative humidity	Atmosphere	Required protection Class of panels/ cabinets/ desks to be provided by Bidder.
Outdoor Location				
55 degree C max.	Atmosphere	100 % Max.	Air (dirty)	IP 55
4 degree C min.	Atmosphere	5 % min.	Air (dirty)	IP 55
Indoor Location				
55 degree C max.	Atmosphere	95 % Max.	Air	IP 54**
4 degree C min.	Atmosphere	5 % min.	Air	IP 54**
Air Conditioned Areas				
24 +/- 5 degree C normal	Atmosphere	95 % Max.	Air	IP 22***
50 degree C max.*	Atmosphere	5 %min.	Air	IP 22***

*** During air conditioning failure.**

****For non-ventilated enclosures. For ventilated enclosures, protection class shall be IP 42.**

*****With a suitable canopy at the top to prevent ingress of dripping water.**

For hazardous areas the protection class shall be in accordance with the requirements of the relevant NEC code for the location.

For PCs, OWS, EWS, Servers, Printers and other peripherals ,maximum temperature limit shall be 35 Deg. C. For LVS the same shall be 25 Deg C and for mini UPS, the same shall be 40 Deg. C max.

5.00.00 GROUNDING SYSTEM

All panels, desks, cabinets shall be provided with a continuous bare copper ground bus. The ground bus shall be bolted to the panel structure on bottom on both sides. The bolts shall face inside of panels.

The system ground shall be isolated from the panel ground with suitable isolators. All internal component grounds or common shall be connected to the system ground, which shall be fabricated of copper flat (size 25mm x 6mm min., length as applicable).

Shield on instrumentation cables shall be grounded on panel side. When shielding termination are required in cabinets furnished under this specification, suitable terminals shall be furnished on copper flat forming system ground. System and shield ground shall be connected to Owner provided earthing strip at 0.0 meter

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	level using suitable size of cable.In case same is not available,separate electronic earthpit shall be provided by the bidder. The Bidder shall submit with the offer recommended grounding scheme required for his system. The exact grounding scheme shall be finalised during detailed engineering.

PART – B

SUB-SECTION – IIIC-02

MEASURING INSTRUMENTS

CLAUSE NO.	TECHNICAL REQUIREMENTS
	MEASURING INSTRUMENTS
1.00.00	MEASURING INSTRUMENTS (PRIMARY AND SECONDARY)
1.01.00	Measuring instruments/equipment and subsystems offered by the Bidder shall be from reputed experienced manufacturers of specified type and range of equipment, whose guaranteed and trouble free operation has been proven. Refer Sub-section Basic Design Criteria. Further, all instruments shall be of proven reliability, accuracy, and repeatability requiring a minimum of maintenance. They shall comply with the acceptable international standards and shall be subject to Employer's approval. All instrumentation equipment and accessories under this specification shall be furnished as per technical specifications, ranges, makes/numbers as approved by the Employer during detailed engineering.
1.02.00	Every panel-mounted instrument requiring power supply shall be provided with a pair of easily replaceable glass cartridge fuses of suitable rating. Every instrument shall be provided with a grounding terminal and shall be suitably connected to the panel grounding bus.
1.03.00	All local gauges as well as transmitters, sensors, and switches for parameters like pressure, temperature, level, flow etc. as required for the safe and efficient operation and maintenance as well as for operator and management information (including all computation) of equipment under the scope of specification shall be provided on as required basis within the quoted lump sum price. For bidding purpose, tentative minimum instruments have been indicated on the P&IDs. However, contractor shall supply any additional local gauges /switches /transmitters / sensors for reasons mentioned above without any additional cost to the Employer.
1.04.00	The necessary root valves, impulse piping, drain cocks, gauge-zeroing cocks, valve manifolds and all the other accessories required for mounting/erection of these local instruments shall be furnished, even if not specifically asked for, on as required basis. The contacts of equipment mounted instruments, sensors, switches etc. for external connection including spare contacts shall be wired out in flexible/rigid conduits, independently to suitably located common junction boxes. The proposal shall include the necessary cables, flexible conduits and accessories for the above purpose. Double root valves shall be provided for all pressure tapping where the pressure exceeds 40 Kg./sq.cm.
1.05.00	For sea water applications, all instruments applications, they shall be provided with wetted parts made of Monel/ Hastelloy C or any other material (if proven ness experience of the proposed material for such applications is established by contractor)

<table>
<tr><th>CLAUSE NO.</th><th>TECHNICAL REQUIREMENTS</th></tr>
<tr><td>1.06.00</td><td>For coastal areas, all instruments shall be provided with durable epoxy coating for housings and all exposed surfaces of the instruments.</td></tr>
<tr><td>2.01.00</td><td>Specification for Electronic Transmitters for Press, Diff Press, DP based Flow, Level measurement.
<table>
<tr><th>Sr.No</th><th>Features</th><th></th><th>Essential/Minimum Requirements</th></tr>
<tr><td>1.</td><td>Type of Transmitter</td><td>:</td><td>Microprocessor based 2 wire type (loop powered), HART protocol compatible.</td></tr>
<tr><td>2.</td><td>Accuracy</td><td>:</td><td>± 0.1% of calibrated span (minimum)</td></tr>
<tr><td>3.</td><td>Output signal</td><td>:</td><td>4-20 mA DC (Analog) along with superimposed digital signal (based on HART protocol)</td></tr>
<tr><td>4.</td><td>Turn down ratio</td><td>:</td><td>10:1 for vacuum/very low pressure applications(i.e<=200mmwc).
30:1 for other applications.</td></tr>
<tr><td>5.</td><td>Stability</td><td>:</td><td>± 0.1% of calibrated span for six months for Ranges up to and including 70 Kg/cm² (g).
± 0.25% of calibrated span for six months for Ranges more than 70 Kg/cm² (g).</td></tr>
<tr><td>6.</td><td>Zero and span drift</td><td>:</td><td>+/- 0.015% per deg.C at max span.
+/-0.11% per deg.C at min. span.</td></tr>
<tr><td>7.</td><td>Load impedance</td><td>:</td><td>500 ohm (min.)</td></tr>
<tr><td>8.</td><td>Housing</td><td>:</td><td>Weather proof as per IP-65, metallic housing with durable corrosion resistant coating.</td></tr>
<tr><td>9.</td><td>Over Pressure</td><td>:</td><td>150% of max. Operating pressure.</td></tr>
<tr><td>10.</td><td>Electrical connection</td><td>:</td><td>Plug and socket type.</td></tr>
<tr><td>11.</td><td>Process connection</td><td>:</td><td>1/2 inch NPT (F)</td></tr>
<tr><td>12.</td><td>Span and Zero adjustment</td><td>:</td><td>Continuous, tamper proof, Remote as well as manual adjustability from instrument with zero suppression and elevation facility.</td></tr>
<tr><td>13.</td><td>Accessories</td><td>:</td><td>-Diaphragm seal, pulsation dampeners, syphon etc. as required by service and operating condition.
-2 valve manifold for absolute & Gauge pressure transmitters, 3-valve manifold for vacuum</td></tr>
</table></td></tr>
</table>

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			pressure transmitters & where DP transmitters are being used for pressure measurement and 5 valve manifolds for DP/Level/Flow application. -For hazardous area, explosions proof enclosure as described in NEC article 500.
14.	Diagnostics & display	:	Self Indicating feature and digital display on transmitter
15.	Power supply	:	24V DC ± 10%.
16.	Adjustment/calibration/ maintenance	:	Using hand held HART calibrator.

Notes

1) LVDT type is not acceptable.

2) Where the process fluids are corrosive, viscous, solid bearing or slurry type, diaphragm seals shall be provided. Parts below the diaphragm shall be removable for cleaning. The entire volume above the diaphragm shall be completely filled with an inert liquid suitable for the application.

2.02.00 SPECIFICATION FOR ELECTRO-MAGNETIC TYPE FLOW TRANSMITTER

S.No.	Features	Essential/Minimum requirement
1.	Type of Transmitter	Microprocessor based 2 wire type, HART protocol compatible, full bore type.
2.	Output signal	4-20 mA DC (Analog) along with superimposed digital signal (based on HART protocol).
3.	Accuracy	+/- 0.5% of calibrated span.
4.	Power supply	24 V DC +/- 10%.
5.	Housing	Weather proof as per IP-65, metallic housing with durable corrosion resistance coating.
6.	Adjustment/calibration/	Using hand held HART calibrator.

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	maintenance	
7.	Zero and Span adjustment	Continuous, tamper proof, remote as well as manual adjustability from instrument. It should be possible to calibrate the instrument without any process flow.
8.	Sensor Material	Corrosion resistant material to suit individual application requirement.
9.	Flow tube	SS304.
10.	Liner	Hard rubber or better material to suit the actual application.
11.	Range	Should be suitable for the required process range.
12.	Display	Integral digital display
13.	Load Impedance	500 ohms (minimum).
14.	Accessories	• All weather canopy shall be provided for protection from direct sunlight and direct rain for open locations. • All mounting accessories required for erection and commissioning shall be provided. • For hazardous area, explosion proof enclosure as described in NEC article 500

Note:-

Four wire type transmitters can also be provided for applications where 2-wire transmitter has some technical limitations, subject to employer's approval during detailed engineering stage. However, in such cases isolated

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4-20 mA DC (analog) output shall be provided. Power supply required for such transmitters shall be 240V AC / 24V DC.

2.03.00 Specification for ULTRASONIC TYPE FLOW TRANSMITTER

S.No.	Features	Essential/Minimum requirement
1.	Type of Transmitter	Non contact Microprocessor based 2 wire type, HART protocol compatible Ultrasonic transmitter. Insertion type.
2.	Output signal	4-20 mA DC (Analog) along with superimposed digital signal (based on HART protocol).
3.	Sensor Accuracy	+/- 2% of calibrated span.
4.	Sensor Repeatability	NA
5.	Power supply	24 V DC +/-10%.
6.	Temperature compensation	To be provided within transducer.
7.	Configuration	
8.	Housing	Weather proof as per IP--65 , metallic housing with durable corrosion resistance coating.
9.	Adjustment/calibration/ maintenance	Using hand held calibrators.
10.	Zero and Span adjustment	Continuous, tamper proof, remote as well as manual to calibrate the instrument without any process flow.
11.	Sensor Material	Corrosion resistant material to suit individual application requirement.
12.	False signal tolerance	Transmitter shall e capable of ignoring false echoes from internal tank/sumps obstructions such as pipes, heating coils or agitator blades. Also transmitter shall have adjustable damping circuitry.
13.	Range	Should be suitable for the required process range.

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14.	Display	LCD display with integral keypad to be provided.
15.	Diagnostics	Loss of echo alarm etc.
16.	Load Impedance	500 ohms minimum
17.	Electrical Connection	Plug and socket
18.	Accessories	• All weather canopy for protection from direct sunlight and direct rain. • All mounting hardware and accessories required for erection and commissioning mounting fittings materials shall be SS 316. • For hazardous area, explosion proof enclosure as described in NEC article 500

2.04.00 **Specification for TEMPERATURE TRANSMITTER**

Following type of 2-wire(loop powered) temperature transmitter (directly powered from 4-20mA input cards of DDCMIS/PLC) shall be provided. The temperature transmitter shall be fully compatible with thermocouples and RTDs being provided by the contractor. Temperature compensation of the thermocouples shall be performed in the temperature transmitter itself.

a). **Single Input Head mounted Temperature Transmitter**

These shall be suitable for mounting in the head of temperature element itself.

b) Single Input DIN-rail mounted Temperature Transmitter

These shall be suitable for mounting on DIN-rails in JBs. The specifications of the JBs shall be same as indicated in Subsection INST CABLE with additional DIN-rails and IP 65 Protection class. This temperature transmitter shall be the ones which are especially designed for DIN-rail mounting with IP 20 protection class. These shall have terminals for input/output provided on front side when mounted on DIN-rail. Head mounted temperature transmitter with clamps to make it suitable

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for DIN-rail mounting shall not be acceptable under this category.

Requirements for each of the above type of temperature transmitters

Output	:	2-wire (power supply from input card of Control System) with 4-20mA output with superimposed HART protocol signal.
Input	:	Same transmitter shall be capable to handle Pt-100 RTD , Thermocouples –K&R types (input type to be selectable at site through HART terminal)
Isolation	:	min. 500 V AC
EMC compatibility	:	as per EN 61326
Operating ambient temperature	:	0 to 85 deg C (without indicator) 0 to 70 deg C (with indicator)
Power supply		24V DC +/- 10%.
Accessories		Mounting arrangements including clamps etc.
Composite Accuracy		

RTD	=<0.4% of 0-250 deg C span
T/C-K type	=<0.4% of 0-600 deg C span
T/C-R type	=<0.4% of 0-1000 deg C span

CJC accuracy (for thermocouples) shall be =< 1 deg C

Notes:-

1. In case of failure (open or burn-out) of RTD/thermocouple, temp. Transmitter shall provide low temperature output.
2. Composite Accuracy is to be calculated as summation of all applicable accuracies of temp transmitter, for converting sensor input to output in 4-20 mA (e.g., basic accuracy, digital accuracy, D/A accuracy, etc.) and temperature effect on these accuracies at ambient temperature of 50 deg C, based on the figure/ formula given in the standard product catalogue for span as specified above for various types of Temperature Elements specified. All such accuracy/ temp effect figures in catalogue shall be first converted to deg C, and then percentage of this converted accuracy in specified span shall be calculated to compare with the specified composite accuracy figures.

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2.05.00 **Specification for TEMP ELEMENTS**

2.05.01 **Specification for Resistance Temperature Detector (RTD)**

Sr. No.	Features		Essential/Minimum Requirements
1	Type of RTD.	:	Pt-100 (100 Ohms resistance at zero degree Centigrade).
2	No. of element	:	Duplex
3	Housing/Head	:	IP-65/Diecast Aluminum. Head of TE to be provided with sufficient space and arrangement to mount head mounted temperature transmitter (as applicable).Plug in connector for external signal cable connection shall be provided. TE terminal head shall be spring loaded for positive contacts with the thermo well..
4	Insulation and Sheathing of RTD	:	Mineral (magnesium oxide) insulation and SS316 sheath, ceramic packed.
5	Calibration and accuracy	:	As per IEC-751/ DIN-43760 Class-A for RTD
6	Characteristic	:	Linear with respect to temp, within ±1/2 of top range value
7	Accessories	:	Thermo well (as specified below) and shall be spring loaded for positive contacts with the well.
8	Standard	:	IEC-751/ DIN-43760 for RTD and ASME PTC-19.3 for thermo well.

NOTES :

1) The specifications for RTDs of winding/ bearings of motor/pump, can be as per their manufacturer standards. The manufacturer shall submit the adequate supporting documents for establishing their standard practice. However the type of RTD shall be Pt100.

2) The specifications of temp elements for air conditioning & ventilation system / process can be as per system manufacturer's standards. The manufacturer shall submit the adequate supporting documents for establishing their standard practice.

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2.05.02 **Specification for Thermocouples**

Sr.No	Features		Essential/Minimum Requirements
1	Type of Thermocouple.	:	16 AWG wire of Chromel-Alumel (Type K) or 24 AWG wire Pt-Rhodium Pt (Type R) depending on operating temperature Range (ungrounded separate junction type).
2	No. of element	:	Duplex
3	Housing/Head	:	IP-65/Diecast Aluminium. Head of TE to be provided with sufficient space and arrangement to mount head mounted temperature transmitter (as applicable). Plug in connectors are to be provided for external signal cable connection. TE terminal head shall be spring loaded for positive contacts with the thermo well.
4	Insulation and Sheathing of Thermocouple	:	Swaged type mineral (magnesium oxide) insulation and SS316 sheath.
5	Calibration and accuracy	:	As per IEC-584/ANSI-MC-96.1(special limits of errors/ class1) for T/C.
6	Characteristic	:	Linear with respect to temp, within ±1/2 percent of top range value.
7	Accessories	:	Thermo well (as specified below)
8	Standard	:	IEC-584/ ANSI MC 96.1 for Thermocouple and ASME PTC-19.3 for Thermo-well.

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Notes :

1) The specifications for thermocouples of bearings metal temp measurements can be as per their manufacturer standards. The manufacturer shall submit the adequate supporting documents for establishing their standard practice However type of thermocouples shall be K type.

2.05.03 **Specification for Thermo well**

Thermo well shall be one piece solid bored type of 316 SS of step-less tapered design, (As per ASME PTC 19.3 1974).

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3.00.00 Hand held calibrator

The hand held type universal calibrator shall be provided for adjustment/calibration/maintenance of the HART compatible transmitters. The hand held calibrator shall be suitable for all types of transmitters supplied in the package. If one type of hand held type calibrator is not suitable for communicating with all types of transmitters then separate hand held calibrator will be provided for that specific type of transmitter.

4.00.00 Specification for Press Gauge, DP Gauge, Temp Gauge, Level Gauge

	FEATURES	**ESSENTIAL/ MINIMUM REQUIREMENTS**		
		Pr. Gauge/ DP Gauge/ Draught gauges	**Temperature Gauge**	**Level Gauge**
1	Sensing Element	Bourdon for high pressure measurement, Diaphragm/ Bellow for low press measurement.	Mercury in steel / inert gas actuated.	Tempered * toughened Borosilicate gauge glass , steel armoured reflex or transparent type.
2	Body material	Die-cast aluminum.	Die-cast aluminum.	Forged carbon steel/ 304 SS.
3	Dial size	150 mm.	150 mm	Tubular covering Process connection± 2%
4	End connection.	1/2 inch NPT (F) as per ASME PTC.	3/4" NPT (F).	
5	Accuracy	±1% of span	± 1% of span	
6	Scale	Linear, 270° arc graduated in metric units.	Linear, 270° arc graduated in °C.	Linear vertical
7	Range	Cover 125% of max.	Cover 125% of	Cover 125% of

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	selection	of scale	max. of scale	max. of scale
8	Over range test	Test pr. for the assembly shall be1.5 to the Design press at 38°C		
9	Housing	Weather and dust proof as per IP-55.	Weather and dust proof as per IP-55.	CS/ 304 SS leak proof.
10	Zero/span adjustment	Provided	Provided	—
11	Identification	Suitable metal service tag shall be provided.		
12	Accessories	Blow out disc, siphon, snubber, pulsation dampener, chemical seal(if required by process) gauge isolation valve.	SS Thermo well	Gasket for all KEL-F shields for transparent type. Vent and drain valves of Steel/ SS as per CS/ Alloy process Requirement. For acid / alkali applications material of drain and vent valves shall be as suitable for these mediums.
13	Material of sensor/ movement	316 SS / 304 SS	316 SS / 304 SS	

Notes:-

1) *Bicolour type level gauges will be provided for applications involving steam and water except for condensate and feed water services.

Length of gauge glass shall not be more than 1400 mm. If the vessel is higher, multiple gauge glasses with 50 mm overlapping shall be provided.

2) Where the process fluids are corrosive, viscous, solid bearing or slurry type, diaphragm seals shall be provided. Parts below the diaphragm shall be removable

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for cleaning. The entire volume above the diaphragm shall be completely filled with an inert liquid suitable for the application.

3) Pressure/ Diff pressure gauges for very low press/ DP measurements can have sensor material other than SS316 e.g. silicon etc., if the offered material is suitable for that application and the offered product is standard product of the manufacture for very low pressure applications.

4) The specifications for gauges which are integral part of motor bearings can be as per their manufacturer standards.

5.00.00 ROTAMETER

Sr. No.	Features		Essential / minimum requirements
1.	Type		Variable area metal tube type.
2.	Fluid media		Water/oil
3.	Tube body		SS 316
4.	Material of float		316 SS
5.	Indicator		Linear scale.
6.	Accessories		Flange, orifice in case of bypass Rota meter (for line size above ~~50~~ 100 mm).
7.	Housing protection class		IP-55
8.	Accuracy		+/- 2% of full range

6.00.00 SPECIFICATION OF ANALYSERS

6.00.01 Common Requirements

1.	Type of electronics	Microprocessor based
2.	Zero & span Adjustment	To be provided
3.	Ambient temp.	50°C
4.	Display	LCD
5.	Enclosure Type / Material	Weather and Dust proof (IP 55), Die cast aluminum with corrosion resistant epoxy coating for external field mounting analysers
6.	Output signals Analog	4-20 mA DC
7.	Error / fault Diagnostic	To be provided.
8.	Power supply	For power supply and distribution, refer scope / and terminal point part of the specification. Conversion / distribution from the terminal point shall be done by contractor. The power supply to all the analyzers / monitors shall be supplied by

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		contractor with all necessary switches, fuses, wiring / cabling and other required accessories etc. for distribution to individual requirements.
	9. Load	500 Ohms minimum
	10. Mounting	All mounting arrangements for the sensors and the monitors are to be provided by the Contractor. SWAS instruments to be mounted in the panel except Hotwell analysers. For the same and other field application free standing cabinet(s) / panel / rack is to be provided by the Contractor for mounting the analysers / transmitters / meters as applicable due to environment.
	11. Other Requirements	All chemical reagents required for silica, phosphate, sodium, chloride, residual chlorine and hydrazine analyzers for 12 months operation is to be supplied in phased manner depending on shelf life.
6.01.00	**Conductivity Analyser**	
	a) Type	For Hot well: Removable (Direct insertion / withdrawal) type of cells. For others: Continuous flow through type
	b) Range	**:** For SWAS analysers, 0-1, 0-10, 0-100 micro mho/cm freely programmable for specific conductivity. 0-1 micro mho/cm log scale for Cation conductivity **:** For others 0-1, 0-10, 0-100, 0- 1000, 0- 10,000 micro mho/cm freely programmable. : 0-2500 ppm for Total Dissolved Solids (TDS).
	c) Accuracy	**:** <=+/- 1 % of reading
	d) Temperature Compensation	**:** Automatic

CLAUSE NO.	TECHNICAL REQUIREMENTS
	e) Response time : <=5 sec. **f) No. of Streams** : Single **g) Other** : Wherever cation conductivity measurement have been specified dual cation exchange column shall be provided.
6.02.00	**pH Analyser** **a) Type** : Cell - flow through **b) Accuracy** : < ± 1% of reading **c) Range** : 6-11 pH freely programmable (For SWAS area) 0 - 14 pH freely programmable (For others) **d) No. of steams** : Single **e) Temp. compensation** : Automatic
6.03.00	**Turbidity Analyser** **a) Type** : Light reflection principle **b) Range** : 0-100, 0-200 NTU programmable **c) Accuracy** : <= 2% for range 0 – 50 NTU <= 5% for range 50 - 200 NTU **d) Response time (90 % of full scale)** : <= 5 minutes. **e) No. of steams** : Single
6.04.00	Residual Chlorine Analyser The analyser shall comply with the following specification requirements, as a minimum **a) Service** : Chlorination Plant **b) Type** : Amperometric type **c) Range** : 0 to 20.0 mg/L (ppm) **d) Accuracy** : <=+/- 5 % (see Note – 1)

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	e) Alarm annunciation	:	High and low alarms to be provided on panel and shall be field adjustable.
	f) Calibration	:	Zero and span adjustment facility to be provided. Final calibration adjustments of the analyser to be done at site and duly verified by titration. Temperature compensation range 0 to 50 deg.C.
	g) Connections	:	All connections for sampling drain etc. to be provided.
	h) Cabling	:	All field cabling power cables and panel wiring etc., to be provided.
	i) Electrodes	:	Platinum/Gold and copper electrodes shall be provided with cell cleaning system.

Note-1: The measurement accuracy shall not be affected by presence of treatment chemicals as chromates, phosphates, de-former highly polluted water, change in temperature etc.

Note-2: Circulating water as sample to residual chlorine analyser shall be taken from hot circulating water pipe work before entry to cooling towers. Exact location and layout of sampling arrangement shall be finalized during detailed Engg. stage. Bidder shall provide necessary pumping system (with 100% standby) for meeting the analyser requirements, if needed. All the drains shall be terminated up to the nearest Employer's plant drainage system.

7.00.00 **SPECIFICATION FOR FLOW ELEMENTS**

7.01.00 Orifice Plate

Essential / Minimum Requirements are:

Type	Concentric as per ASME PTC-19.5 (Part-II), ISA RP-3.2, 1960 or BS-1042 or ISO 5167
Material	316 SS
Thickness	3 mm for main pipe diameter up to 300 mm and 6 mm for main pipe diameter above 300 mm.
Material of branch pipe	Same as main pipe
Root valve type	Globe

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	Root valve material	316 SS
	Root valve size	**1 / 2 inch or 1 inch (as applicable)**
	Impulse pipe of same material up to root valve	Required
	Tappings	**Flanged weld neck or D & D/2 with 3 pairs of tapping (as applicable). Root valves to be provided in all the tappings.**
	Beta Ratio	Around 0.7
	Beta Ratio calculation to be submitted	Yes
	Assembly drg. and flow Vs DP Curves	Yes
	Accessories	Root valves, flanges, Vent/drain hole (As applicable)
	Note: Contractor shall submit certified flow calculation and differential pressure v.s. flow curves for each element for Employer's approval. Sizing calculation, precise flow calculation for all the flow elements, fabrication and assembly drawings and installation drawings shall be submitted for Employer's approval.	
7.02.00	**Flow Nozzle**	
	Essential / Minimum Requirements are:	
	Type	Long radius, welded type as per ASME PTC-19.5 (Part-III) or BS-1042 or ISO 5167
	Material	316 SS
	Thickness	Suitable for intended application
	Material of branch pipe	Same as main pipe
	Root valve type	Globe
	Root valve material	316 SS
	Root valve size	**1 / 2 inch or 1 inch (as applicable)**
	Impulse pipe of same material up to root valve	Required

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	Tappings	**Flanged weld neck or D & D/2 with 3 pairs of tapping (as applicable). Root valves to be provided in all the tappings.**
	Beta Ratio	Around 0.7
	Beta Ratio calculation to be submitted	Yes
	Assembly drg. and flow Vs DP Curves	Yes
	Accessories	Root valves, flanges, Vent/drain hole (As applicable)

Note: Contractor shall submit certified flow calculation and differential pressure v.s. flow curves for each element for Employer's approval. Sizing calculation, precise flow calculation for all the flow elements, fabrication and assembly drawings and installation drawings shall be submitted for Employer's approval.

8.00.00 **SOLENOID VALVES**

Solenoid valves shall fulfil the following requirements :

a. Type 2/3/4 way SS 316/Forged Brass (depending on the application subject to Employer’s approval during detailed Engg.)

b. Power supply 24 V DC ± 10%.

c. Plug and socket electrical connection.

d. Insulation : Class ‘H’

PART – B

SUB-SECTION – IIIC-03

PROCESS CONNECTION & PIPING

CLAUSE NO.	TECHNICAL REQUIREMENTS
	PROCESS CONNECTION AND PIPING
1.00.00	**PROCESS CONNECTION PIPING**
1.01.00	The Contractor shall provide, install and test all required material for completeness of Impulse Piping System and Air Piping System as per the requirements of this Sub-section enclosed installation drawings and source connection drawings on as required basis for the connection of instruments and control equipment to the process and make the system complete. The Contractor shall furnish during detailed engg. all relevant drawings, material and tech. specifications of various items service wise for Employer's approval.
1.01.01	All materials supplied under this Sub-section shall be suitable for intended service, process, operating conditions and type of instruments used and shall fully conform to the requirements of this specification. The material offered by the Bidder shall be from reputed, experienced manufacturer whose guaranteed and trouble free operation has been proven at least for two years in not less than two pulverised coal fired utility stations.
1.02.00	IMPULSE PIPING, TUBING, FITTINGS, VALVES AND VALVE MANIFOLDS
1.02.01	All impulse pipe shall be of seamless type conforming to ANSI B36.10 for schedule numbers, sizes and dimensions etc. The material of the impulse pipe shall be same as that of main process pipe. For protection against sea environment,all impulse pipes,fittings etc.shall be provided with durable epoxy coating with poly urethane furnish.
1.02.02	All fittings shall be forged steel and shall conform to ANSI B16.11. . The material of forged tube fittings for shaped application (e.g. Tee, elbow etc.) shall be ASTMA 182 Gr. 316 H for high pressure/ temperature applications (as defined above) and ASTMA 182 Gr. 316L for other applications. The material for bar stock tube fitting (for straight application) shall be 316 SS. Metal thickness in the fittings shall be adequate to provide actual bursting strength equal to or greater than those of the impulse pipe or SS tube, with which they are to be used.
1.02.03	The source shut-off (primary process root valve) and blow down valve shall be of 1/2 inch size globe valve type for all applications except for air and flue gas service wherein no source shut-off valves are to be provided.The disc and seat ring materials of carbon steel and alloy steel valves be ASTM A-105 and ASTM A-182, Gr. F22, hard faced with stellite (minimum hardness - 350 BHN.) The surface finish of 16 RMS or greater is required in the area of stem packing. The valve design shall be such that the seats can be reconditioned and stem and disc may be replaced without removing the valve body from the line.
1.02.04	The valve manifolds shall be of 316 stainless steel with pressure rating suitable for intended application. 2 valve manifold and 3-valve manifold shall be used for pressure measurements using pressure transmitters/ pressure switches and diff. pressure transmitter/ switches respectively. 5-valve manifold shall be used for remaining applications like DP, flow and level measurements.
1.02.05	For Pr./D.P gauges in fluid application two-way globe valve on each impulse line to the instrument and in A/F application two-way gate valve on each impulse line to the

CLAUSE NO.	TECHNICAL REQUIREMENTS
	instrument shall be provided near the instrument. These shall be in addition to the three ways gauge cock provided alongwith the pr./D.P gauges.
2.00.00	**AIR SUPPLY PIPING**
2.01.00	All pneumatic piping, fittings, valves, air filter cum regulator and other accessories required for instrument air for the various pneumatic devices/ instruments shall be provided.
2.01.01	This will include as a minimum air supply to pneumatically operated control valves, actuators, instruments, continuous and intermittent purging requirements of etc.
2.02.00	For individual supply line and control signal line to control valve, 1/4-inch size light drawn tempered copper tubing conforming to ASTM B75 shall be used. The thickness of cu-tubing shall not be less than 0.065 inch and shall be PVC coated. The fittings to be used with copper tubes shall be of cast brass, screwed type.
2.03.00	All other air supply lines of 1/2 inch to 2 inch shall be of mild steel hot dipped galvanized inside and outside as per IS-1239, heavy duty with threaded ends. The threads shall be as per ASA B.2.1. Fittings material shall be of forged carbon steel A234 Gr. WPB galvanized inside and outside, screwed as per ASA B2.1. Dimensions of fittings shall be as per ASA B16.11 of rating 3000 lbs.
2.04.00	All instrument air filters cum regulator set with mounting accessories shall be provided for each pneumatic device requiring air supply. The filter regulators shall be suitable for 10-kg/ sq.cm max. Inlet pressure. The filter shall be of size 5 microns and of material sintered bronze. The air set shall have 2-inch size pressure gauge and built in filter housing blowdown valve. The end connection shall be as per the requirement to be finalised during detailed engineering.
2.05.00	All the isolation valves in the air supply line shall be gate valves as per ASTM B62 inside screw rising stem, screwed female ends as per ASA B2.1. Valve bonnet shall be union type & trim material shall be stainless steel, body rating 150 pounds ASA. The valve sizes shall be ½ inch to 2 inch.
3.00.00	**SAMPLE PIPING SYSTEM**
3.01.00	This shall include piping, fittings, valves and accessories from tapping points upto Contractor's conditioning panel/sample coolers and/or Analysers. All sample piping shall be 3/4" NB seamless type of material ASTM A213 TP 316 H, conforming to ANSI B36.19. The schedule number shall be suitable for the particular application.
3.02.00	All fittings shall be socket welding type and of material ASTMA182 F316H conforming to ANSI B 16.11.
3.03.00	Single and multi tubes shall run with the minimum number of changes in direction. Suitable identification tags shall be provided for easy check up and for proper connections.

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3.04.00	The valves to be used in sample piping shall be of globe type, forged construction and stainless steel conforming to ASTM A182. The pressure temperature ratings shall be as per ANSI B16.34. The valve design shall be such that the seats can be reconditioned and stem and disc can be replaced without removing valve body from the line.
4.00.00	**INSTALLATION AND ROUTING**
4.01.00	Instrument Piping System
4.01.01	For steam and liquid measurements, the impulse pipe should preferably slope downward from source connection to instrument and instrument shall be installed below the source point. If due to any reason instrument is installed above the source point, the impulse pipe should slope upwards continuously and a 'pigtail' should be provided at the instrument to assure water seal for temperature protection. For vacuum measurements instrument shall be installed above source point and impulse pipe should slope upwards.
4.01.02	Impulse piping for air and flue gas shall slope upwards and instrument shall be installed above source point. If this requirement cannot be met special venting or drain provision shall be provided with vent & drain lines alongwith isolation valves and other accessories including drainpipes. This drain is to be connected to plant drain through open funnel also.
4.01.03	All impulse piping shall be installed to permit free movement due to thermal expansion. Wherever required expansion loops shall be provided.
4.01.04	Special accessories such as condensing pots/ reservoirs shall be provided and installed wherever required. In any case condensing pots shall be provided for all level measurements in steam and water services, all flow measurement in steam services and flow measurements water services above 120 Deg. C.
4.01.05	Colour coding of all impulse pipes shall be done by the bidder in line with the colour coding being followed for the parent pipes.
4.02.00	Instrument Air & Service Air Piping/ Tubing System
4.02.01	Instrument air & service air headers and their branches with all associated fittings & accessories shall be provided for giving supply to all consumers, as per the requirements. Air piping shall be installed always with a slope of over 1/20 to prevent accumulation of water within the pipe.
4.02.02	Single and multi tubes shall run with the minimum number of changes in direction. Suitable identification tags shall be provided for easy checkup and for connections.
5.00.00	**PIPING/TUBING SUPPORT**
5.01.00	Impulse piping and sample piping shall be supported at an interval not exceeding 1.5 meters. Each pipe shall be supported individually using slotted angle mounted clamps with necessary fixtures. Tubing shall run in proper perforated trays with proper cover. Tubing shall be supported inside the trays by aluminium supports. Hangers and other fixtures required for support of piping and trays shall be provided, either by welding or by bolting on walls, ceilings and structures. Hanger clamps and

CLAUSE NO.	TECHNICAL REQUIREMENTS
	other fastening hardware shall be of corrosion resistant metals and hot-dip galvanized.
6.00.00	**SHOP AND SITE TESTS**
6.01.00	General Requirements
6.01.01	The equipment and work performed as per this Sub-section shall be subject to shop and site test as per requirements of Sub-section-Q (Quality Assurance & Inspection) other applicable clauses of this Sub-section and Employer approved quality assurance plan.
6.01.02	Hydrostatic and pneumatic tests shall be performed on all pipes, tubing and systems and shall conform to ANSI B31.1.
6.02.00	Hydrostatic Testing
6.02.01	All instrument piping/ tubing shall be hydrostatically tested upon completion of erection. The test pressure shall be 1.5 times the maximum process pressure. The test shall be performed either with the testing of associated process piping or without the associated process piping (by closing the root valve). In both the cases the instrument shall be isolated by closing the shut-off valve.
6.03.00	Air Testing
6.03.01	All air headers & branch pipes shall be air tested by pressure decay method as per ANSI B31.1. Flexible hoses and short signal tubing shall be tested at normal pressure for leakage. Long signal tubing shall be tested by charging each tube with air at 2 kg/ sq. cm. through a bubbler sight glass. The boiler draft and vacuum piping shall be air tested by the same method as long signal tubing.
7.00.00	**INSTRUMENT INSTALLATION**
	Instruments are not to be mounted directly on pipes etc. Transmitters , Temperature elements, switches, devices, etc. mounted in the field shall be suitably grouped together to the extent possible and mounted In local instrument racks with suitable canopy near to the instrument source connection point. These local instrument racks shall be furnished as per the actual requirements finalised during detailed engineering stage. The exact construction details of local instrument racks with canopy shall be finalised during detailed engineering stage. Local instrument racks with canopy are to be furnished by the conractor on as required basis within his quoted lumpssum price.
8.00.00	**For Sea Water Applications following to be provided**

System/Line Description	Sea Water Applications
Piping Class	S
Impulse Pipe Material	ASTM-A 213 TP 316L

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Schedule (Size)	80(1/2 inch)
Materials for Fitting/Valve Body	ASTM-A 182 316L
Valve Stem Material	-do-
Rating of Piping/ Fittings	3000lb
Pr. Class of Valve	800

PART – B

SUB-SECTION – IIIC-04

INSTRUMENTATION CABLES

CLAUSE NO.	TECHNICAL REQUIREMENTS

INSTRUMENTATION AND POWER SUPPLY CABLE

1.00.00 **INSTRUMENTATION CABLE, POWER SUPPLY CABLE, INTERNAL WIRING AND ELECTRICAL FIELD CONSTRUCTION MATERIAL**

1.01.00 **General Requirements**

1.01.01 The Bidder shall supply, erect, terminate and test all instrumentation cables for control and instrumentation equipment/devices/systems included under Bidder's scope as illustrated in the enclosed Drg. No. 0000-999-POI-A-021 and ensuring completeness of the control system.

1.01.02 Any other application where it is felt that instrumentation cables are required due to system/operating condition requirements, are also to be provided by Contractor.

1.01.03 Other type of cables like fiber optic/co-axial cables for system bus, cables for connection of peripherals etc. (under Contractor's scope) are also to be furnished by the Contractor.

1.01.04 Contractor shall supply all cable erection and laying hardware from the main trunk routes like branch cable trays/sub-trays, supports, flexible conduits, cable glands, lugs, pull boxes etc. on as required basis for all the systems covered under this specification.

1.01.05 Wherever the quantity has been defined as on as required basis, the same are to be furnished by contractor on as required basis within his quoted lump sump price without any further cost implication to the Owner.

2.00.00 **Specification of Instrumentation cable**

1.02.00 **Common Requirements**

S. No.	Property	Requirement
1	Voltage grade	225 V (peak value)
2.	Codes and standard	Refer to clause no:1.00.00
3.	Continuous operation suitability	At 70 deg. C for all types of cables, and at 205 Deg C for Type-C cables.

CLAUSE NO.	TECHNICAL REQUIREMENTS

S. No.	Property	Requirement
4.	Marking	a) Progressive automatic on-line sequential marking of length in meters to be provided at every one meter on outer sheath. b) Marking to read 'FRLS' to be provided at every 5 meters on outer sheath except for Type-C cable c) Durable marking at intervals not exceeding 625 mm shall include manufacturer's name, insulation material, conductor's size, number of pairs, voltage rating, type of cable, year of manufacturer to be provided on outer sheath.
5.	Allowable Tolerance on overall diameter	+/- 2 mm (maximum) over the declared value in data sheet
6.	Variation in diameter	Not more than 1.0 mm throughout the length of cable.
7.	Ovality at any cross-section	Not more than 1.0 mm
8.	MAXI-TERMI suitability	To be provided
9.	Color	The outer sheath shall be of blue color.
10.	Others	a) Cables shall be suitable for laying in conduits, ducts, trenches, racks and underground-buried installation b) Repaired cables shall not be acceptable.

1.03.00 **Specific Requirements**

Specification Requirements	Type-A cable	Type-B cable	Type F & G cable	Type-C cable
A. Conductors				
Cross section area	0.5 sq. mm			
Conductor material	ANSI type KX	ANSI type SX	Annealed bare copper	ANSI type KX
Colour code	Yellow-Red	Black-Red	As per VDE-815	Yellow-Red

CLAUSE NO.	TECHNICAL REQUIREMENTS			
	Conductor Grade	As per ANSI MC 96.1	Electrolytic	As per ANSI MC 96.1
	No & dia of strands	7x0.3 mm (nom)		
	No. of Pairs	As mentioned in contract quantities		
	Max. conductor loop resistance per Km (in ohm) at 20 deg. C	As per ANSI MC 96.1	73.4	As per ANSI MC 96.1
	Reference Standard	As per ANSI MC 96.1	VDE-815	As per ANSI MC 96.1
	B. Insulation			
	Material	Extruded PVC type YI 3		Teflon (i.e. extruded FEP)
	Thickness in mm (Min/Max)	0.25/0.35		0.4 / 0.50 (nominal)
	Volume Resistivity (Min) in ohm-cm	1 x 10^{14} at 20 deg. C & 1x10^{11} at 70 deg. C.		2.8x 10^{14} at 20 deg. C & 2x10^{11} at 205 deg. C.
	C. Pairing & Twisting			
	Max. lay of pairs (mm)	50		
	Single layer of binder tape on each pair provided	Each core printed with number or Numbered binder tape to provided on each pair	Yes	Each core printed with number or Numbered binder tape to be provided on each pair
	Bunch (Unit Formation) for more than 4P	N.A	To be provided	N.A
	Conductor /pair identification as per VDE0815	N.A.	To be provided	N.A.
	D. Shielding			
	Type of shielding	Al-Mylar tape		

CLAUSE NO.	TECHNICAL REQUIREMENTS

Individual pair shielding	No	To be provided for F-type cable	No
Minimum thickness of Individual pair shielding	No	0.028mm (28 micron)	No
Overall cable assembly shielding	To be provided		
Minimum thickness of Overall cable assembly shielding	0.055 mm (55 micron)		
Coverage Overlapping	20%		
Drain wire provided for individual shield	N.A.	Yes (for F-type) Size- 0.5 sqmm No of strands-7 Dia of strands- 0.3mm Annealed Tin coated copper	N.A.
Drain wire provided for overall shield	Yes. Size- 0.5 sqmm No of strands-7 Dia of strands- 0.3mm Annealed Tin coated copper		
E. FILLERS (if applicable)			
Non-hygroscopic, flame retardant	To be provided		
F. Outer Sheath			
Material	Extruded PVC compound YM1 with FRLS properties		Teflon (i.e. extruded FRP)
Minimum Thickness at any point	1.8 mm		0.4 mm
Nominal Thickness at any point	>1.8 mm		0.5 mm
Resistant to water, fungus, termite & rodent attack	Required		

CLAUSE NO.	TECHNICAL REQUIREMENTS

Minimum Oxygen index as per ASTMD-2863	29 %		N.A.
Minimum Temperature index as per ASTMD-2863	250 deg.C		N.A.
Maximum Acid gas generation by weight as per IEC-60754-1	20%		N.A.
Maximum Smoke Density Rating as per ASTMD-2843	60% (defined as the average area under the curve when the results of smoke density test plotted on a curve indicating light absorption vs. time as per ASTMD-2843)		N.A.
Reference standard	VDE207 Part 5, VDE-816		VDE207 Part 6 & ASTM D2116
G. Electrical Parameters			
Mutual Capacitance Between Conductors At 0.8 Khz (Max.)	200 nF/km	120 nF/km for F type 100 nF/km for G-type	200 nF/km
Insulation Resistance (Min.)	100 M Ohm/Km		
Cross Talk Figure (Min.) At 0.8 Khz	60 dB	60 dB	60dB
Characteristic Impedance (Max) At 1 Khz	N.A.	320 OHM FOR F-TYPE 340 OHM FOR G-TYPE	N.A.
Attenuation Figure At 1 Khz (Max)	N.A.	1.2 db/km	N.A.
H. Complete Cable			
Complete Cable assembly	Shall pass Swedish Chimney test as per SEN-SS 4241475 class F3.		N.A.
Flammability	Shall pass flammability as per IEEE-383 read in conjunction to this specification		As per manufacturer's standard subject to employer's approval

CLAUSE NO.	TECHNICAL REQUIREMENTS

I. Accessories		
Cable accessories of flame retardant quality.	Yes. (Accessories such as harnessing components, markers, bedding, cable jointer, binding tape etc.)	
J. Cable Drum		
Type	Non-returnable wooden drum (wooden drum to be constructed from seasoned wood free from defects with wood preservative applied to the entire drum) or steel drum. For type-C cables, drums of other material as per manufacturers practice can be provided subjected to employers approval.	
Outermost layer covered with waterproof paper	Yes	
Painting	Entire surface to be painted	
Length	1000 m ± 5% for up to & including 12 pairs 500 m ± 5% for above12 pairs	
Drum Marking	Manufacturer's name, Employer's name, address and contract number, item no., type, size and length of the cable, net and gross weight stenciled, Reference to National/International Standard, Operating Voltage, Country & Year of Manufacture on drum.	

3.00.00 **SPECIFICATION OF OPTICAL FIBER CABLES (OFC)**

3.01.00 Optic Fiber cable shall be 4/8/12 core, galvanised corrugated steel taped armoured, fully water blocked with dielectric central member for outdoor/indoor application so as to prevent any physical damage. The cable shall have multiple single-mode or multi mode fibers on as required basis so as to avoid the usage of any repeaters. The core and cladding diameter shall be 9 +/- 1 micrometer and 125 +/- 1 micrometer respectively. The outer sheath shall have Flame Retardant, UV resistant properties and are to be identified with the manufacturer's name, year of manufacturer, progressive automatic sequential on-line marking of length in meters at every meter on outer sheath.

3.02.00 The cable core shall have suitable characteristics and strengthening for prevention of damage during pulling viz. Steel central member, Loose buffer tube design, 4 fibers per buffer tube (minimum), Interstices and buffer tubes duly filled with Thixotropic jelly etc. The cable shall be suitable for a maximum tensile force of 2000 N during installation, and once installed, a tensile force of 1000 N minimum. The compressive strength of cable shall be 3000 N minimum& crush resistance 4000 N minimum. The operating temperature shall be –20 deg. C to 70 deg.C.

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3.03.00	All testing of the fiber optic cable being supplied shall be as per the relevant IEC, EIA and other international standards.
3.04.00	Bidder to ensure that minimum 100% cores are kept as spares in all types of optical fibre cables.
3.05.00	Cables shall be suitable for laying in conduits, ducts, trenches, racks and under ground buried installation.
3.06.00	Spliced / Repaired cables are not acceptable.
3.07.00	Penetration of water resistance and impact resistance shall be as per IEC standard.
4.00.00	**INSTRUMENTATION CABLE INTERCONNECTION AND TERMINATION PHILOSOPHY** The cable interconnection philosophy to be adopted shall be such that extensive grouping of signals by large scale use of field mounted Group Junction Boxes (JBs) at strategic locations (where large concentration of signals are available, e.g. valves limit & torque switches, switchgear) is done and consequently cable with higher number of pairs are extensively used. The details of termination to be followed are mentioned in the given Table A. TABLE A: CABLE TERMINATION TO BE FOLLOWED

Application		Type Of Termination		Type Of Cable
FROM (A)	TO (B)	END A	END B	
Valves/dampers drives (Integral Junction box)	Marshalling cubicle/ Marshalling cum termination Cubicle/local group JB	Plug in connector	Posts mount cage clamp type.	G
Transmitters, Process Actuated switches mounted in LIE/LIR	Integral Junction box of LIE/LIR	Plug in connector	Cage clamp (Rail mount) type.	F,G
RTD heads	Local junction box	Plug in connector	Cage clamp (Rail mount) type.	F
Thermocouple	CJC Box (if applicable)	Plug in connector	Cage clamp (Rail mount) type.	A,B,C*
Other Field Mounted Instrument	Local JB/Group JB	Plug in connector	Screwed, Cage clamp (Rail mount) type	F,G
RTD	Temperature transmitter	Plug in connector	Screwed, Cage clamp type	F

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Thermocouple	Temperature transmitter	Plug in connector	Screwed, Cage clamp type	A,B,C*
Local Junction box, Temperature Transmitter, Int. Junction box of LIE/ LIR/Group JB/ MCC/SWGR	Group JB	Cage clamp (Rail mount) type.	Cage clamp (Rail mount) type.	F,G
Local Junction box, Temperature Transmitter, Int. Junction box of LIE/ LIR/Group JB/ MCC/SWGR	Marshalling Cubicle/ Marshalling cum Termination Cabinet	Cage clamp (Rail mount) type.	Posts mount cage clamp type.	F,G
Marshalling cubicle/ Termination Cabinet	Electronic system cabinet	Cage clamp Post mounted type.	Plug in connector/Other System as per manufacturer's Standard	Internal wiring
Marshalling/ Termination System Cabinets	UCD mounted equipments	Post mount cage clamp type.	Plug in connector/Cage clamp type (rail mounted).	F,G (with plug-in connector at one end)
DDCMIS/PLC cabinets	PC, Printers etc.	Plug in connector	Plug in connector	Mfr.'s Standard

Notes

1. Normally 10% spare cores shall be provided when the numbers of pairs of cables are more than four pairs except for pre-fabricated cables which shall be as per manufacturer's standard.
2. For analog signals, individual pair shielding & overall shielding & for Binary signals, only overall shielding of instrumentation cables shall be provided.
3. Also refer drg. 0000-999-POI-A-021.
4. *For high temperature applications only.

5.00.00 TERMINAL BLOCKS

5.01.00 All terminal blocks shall be rail mounted/post mounted, cage clamp type with high quality non-flammable insulating material of melamine suitable for working temperature of 105 deg. C. The terminal blocks in field mounted junction boxes, temperature transmitters, instrument enclosures/racks, etc., shall be suitable for cage clamp connections. The terminal blocks in Control Equipment Room logic/termination/marshalling cubicles shall be suitable for post mounted cage clamp connection at the field input end. The terminal blocks for DDCMIS input/output connections from/to SWGR/MCC, Actuators with Integral Starter (for coupling relays and check back signals of 11 kV and 3.3 kV auxiliaries, LT drives/valves & dampers/solenoids, CT & VT, etc.) shall be provided with built in test and disconnect facilities complete with plug, slide clamp, test socket etc. The exact type of terminal

CLAUSE NO.	TECHNICAL REQUIREMENTS
	blocks to be provided by the Bidder and the technical details of the same including width etc. shall be subject to Employer's approval.
5.02.00	All the terminal blocks shall be provided complete with all required accessories including assembly rail, locking pin and section, end brackets, partitions, small partitions, test plug bolts and test plug (as specified above for SWGR connections) transparent covers, support brackets, distance sleeves, warning label, marking, etc.
5.03.00	The marking on terminal strips shall correspond to the terminal numbering on wiring diagrams. At least 20% spare unused terminals shall be provided everywhere including local junction boxes, instrument racks/enclosures, termination/marshalling cabinets, etc. All terminal blocks shall be numbered for identification and grouped according to the function. Engraved labels shall be provided on the terminal blocks.
5.04.00	For terminating each process actuated switches, drive actuators, control valves, Thermocouple, RTD, etc. in Local Junction Boxes, etc, refer Drg no.s 0000-999-POI-A-065, 0000-999-POI-A-065A.
5.05.00	The terminal blocks shall be arranged with at least 100 mm clearance between two sets of terminal blocks and between terminal blocks and junction box walls.
5.06.00	For ensuring proper connections, Bidder shall provide suitable accessories, along with insulation sleeves. The exact connecting accessory shall be finalised as per application during detail engineering stage subject to Employer's approval without any cost repercussions.
5.07.00	Internal wiring in factory pre-wired electronic equipment cabinets may be installed according to the Bidder's standard as to wire size and method of termination or internal equipment. Terminal blocks for connection of external circuits into factory prewired electronic equipment cabinets shall meet all the requirements as specified above.
6.00.00	**INTERNAL PANELS/ SYSTEM CABINETS WIRING**
6.01.00	Internal panel/cabinet wiring shall be of multi-stranded copper conductor with FRLS PVC insulation without shield and outer sheath meeting the requirements of VDE 0815.
6.02.00	Wiring to door mounted devices shall be done by 19 strand copper wire provided with adequate loop lengths of hinge wire so that multiple door opening shall not cause fatigue breaking of the conductor.
6.03.00	All internal wires shall be provided with tag and identification nos. etched on tightly fitted ferules at both ends in Employer's approved format. All wires directly connected to trip devices shall be distinguished by one additional red colour ferrule.
6.04.00	All external connection shall be made with one wire per termination point. Wires shall not be tapped or spliced between terminal points.
6.05.00	All floor slots of desk/panels/cabinets used for cable entrance shall be provided with removable gasketed gland plates and sealing material. Split type grommets shall be used for prefabricated cables.

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6.06.00	All the special tools as may be required for solder less connections shall be provided by Bidder.
6.07.00	Wire sizes to be utilised for internal wiring. (i) Current (4-20 mA), low voltage signals (48V); Ammeter/Voltmeter circuit, control switches etc. for electrical system. — 0.5 Sq.mm. (ii) Power supply and internal illumination. — 2.5Sq.mm. minimum (shall be as per load requirement.)
7.00.00	**INSTRUMENTATION CABLE INSTALLATION AND ROUTING**
7.01.00	All cables assigned to a particular duct/conduit shall be grouped and pulled in simultaneously using cable grips and suitable lubricants. Cables removed from one duct/conduit shall not be reused without approval of Employer.
7.02.00	Cables shall be segregated as per IEEE Std.-422. In vertically stacked trays, the higher voltage cable shall be in higher position and instrumentation cable shall be in bottom tier of the tray stack. The distance between instrumentation cables and those of other system shall be as follows: From 11 kV/6.6 kV/3.3 kV tray system - 914 mm From 415V tray system - 610 mm From control cable tray system - 305 mm
7.03.00	Cables shall terminate in the enclosure through cable glands. All cable glands shall be properly gasketed. Fire proof sealing (to prevent ingress of dust entry and propagation of fire) shall be provided for all floor slots used for cable entrance. Compression cable glands (double for armoured and single for other cables) shall be provided.
7.04.00	All cables shall be identified by tag. Nos. provided in Employer's approved format at both the ends as well as at an interval of 5 meters.
7.05.00	Line voltage drop due to high resistance splices, terminal contacts, insulation resistance at terminal block, very long transmission line etc. shall be reduced as far as practicable.
706.00	The cables emanating from redundant equipment/devices shall be routed through different paths. The above segregation of cables & wiring for redundant equipments/devices shall be in accordance with IEEE-Std-422.
8.00.00	**CABLE LAYING AND ACCESSORIES**
8.01.00	**CABLE LAYING** 1 Cables shall be laid strictly in line with cable schedule. 2 Identification tags for cables.

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Indelible tags to be provided at all terminations, on both sides of wall or floor crossing, on each conduit/duct/pipe entry/exit, and at every 20 m in cable trench/tray.

3 Cable tray numbering and marking.

To be provided at every 10m and at each end of cable way & branch connection.

4 Joints for less than 250 Meters run of cable shall not be permitted.

5 Buried cable protection

With concrete slabs; Route markers at every 20 Meters along the route & at every bend.

6 Road Crossings

Cables to pass through buried high density PE pipes encased in PCC. At least 300 mm clearance shall be provided between

- HT power & LT power cables,
- LT power & LT control cables
- LT control & instrumentation cables,

Spacing between cables of same voltage grade shall be in accordance with the derating criteria adopted for cable sizing.

7 Segregation (physical isolation to prevent fire jumping)

a All cable associated with the unit shall be segregated from cables of other Units.

b Interplant cables of station auxiliaries and unit critical drives shall be segregated in such a way that not more than half of the drives are lost in case of single incident of fire.

8 Cable clamping

All cables laid on trays shall be neatly dressed up & suitably clamped/tied to the tray. For cables in trefoil formation, trefoil clamps shall be provided.

9 **Optical fiber cables inside conduit shall be laid on cable trays wherever available and feasible. In areas where the same are required to be buried, the same shall be buried in separate trench approx.1.6 meter depth, to be laid in 2" GI/rodent proof HDPE conduits covered with sand, brick and soil along the pipe line route;**

While crossing roads - to be laid in GI/rodent proof HDPE conduits with sand filling at bottom and sand, soil filling at top with cement concrete;

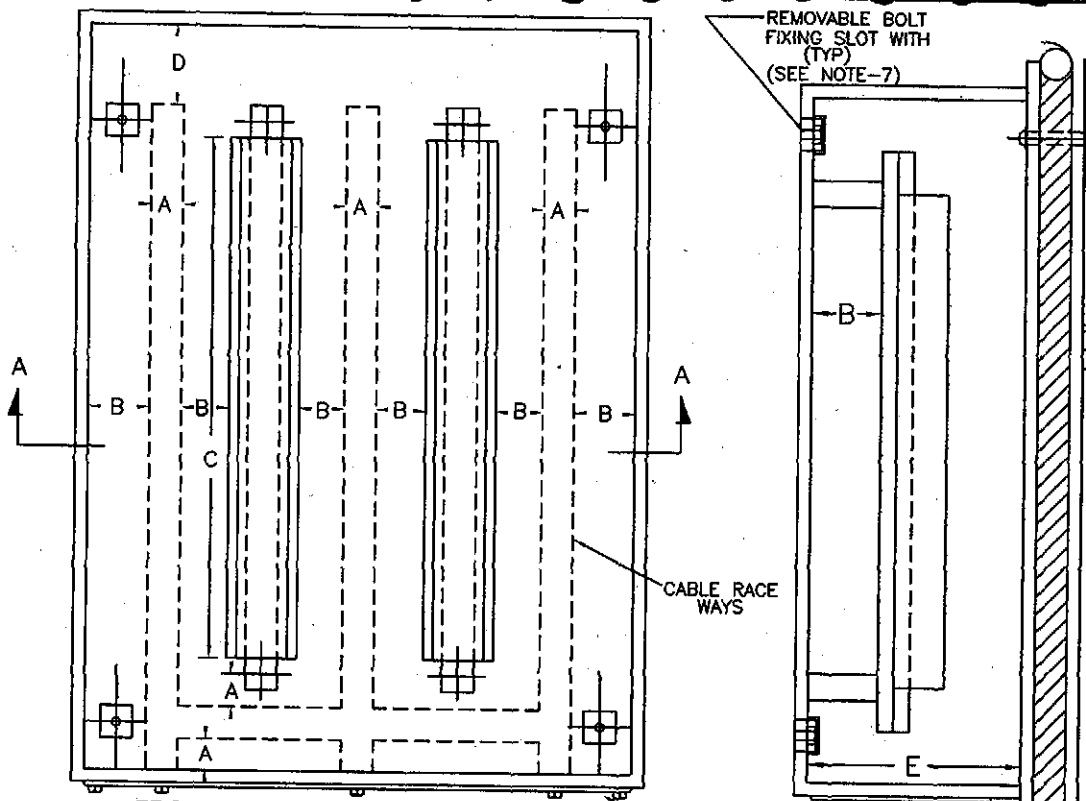
While crossing canals/river- to be laid in GI/rodent proof HDPE conduits within hume pipe.

CLAUSE NO.	TECHNICAL REQUIREMENTS
8.02.00	Bidder shall supply and install all cable accessories and fittings like Light Interface Units, Surge suppressors, Opto isolators, Interface Converters, Fibre Optic Card Cage, Fibre Optic Line Driver, Repeater / Modem (for Optical Fibre Cables), cable glands, grommets, lugs, termination kits etc. on as required basis.
8.03.00	Bidder shall furnish two completely new sets of cable termination kits like Crimping tools, etc., which are required for maintenance of the system as per the type of termination used.
8.04.00	Cables, which terminate in cabinets of draw out sections shall have sufficient cable coiled in the bottom of the cabinet to permit full withdrawal of draw out sections without disconnecting the cables. When prefabricated cables with factory connectors on both ends are longer than required, the excess cable shall be coiled in the bottom of one or both termination cabinets.
8.05.00	No splices shall be made in conductors for instrument and control circuits except where required at connections to devices equipped with factory installed pigtails. Such splices shall be made only in approved splicing boxes of fitting with removable cover. The splices shall be made with sufficient slack left in the wires to permit withdrawal of the splice from the splicing box for ease of future disconnection of the splices. All exposed conductor or connector surfaces shall be covered with a minimum of three half-lapped layers of all weather vinyl plastic electrical tape. Taping shall extend a minimum of two cable diameters over the cable jacket and a similar distance over the other insulation or connections requiring insulation.
8.06.00	The Bidder shall be responsible for proper grounding of all equipment under this package. Further, proper termination of cable shields shall be verified and the grounding of the same shall be coordinated so as to achieve grounding of all instrumentation cable shields at same potential. This shall be completed prior to system tests. All the cables etc. required for grounding of all equipments supplied under this package are to be supplied by the Bidder.
8.07.00	The Contractor shall take full care while laying / installing cables as recommended by cable manufacturers regarding pulling tensions and cable bends. Cables damaged in any way during installation shall be replaced at the expense of the Contractor.
9.00.00	**FIELD MOUNTED LOCAL JUNCTION BOXES**
	(i) No. of ways: 12/24/36/48/64/72/96/128 with 20% spares terminals.
	(ii) Material and Thickness: 4mm thick Fiberglass Reinforced Polyester (FRP).
	(iii) Type: Door gasket shall be of synthetic rubber.
	(iv) Mounting clamps and accessories: Suitable for mounting on walls, columns, structures etc. The brackets, bolts, nuts, screws, glands and lugs required for erection shall be of brass, included in Bidders scope of supply. Raceways shall be provided inside JBs for proper termination of cables.
	(v) Type of terminal blocks: Rail mounted cage-clamp type suitable for conductor size upto 2.5 mm^2. A M6 earthing stud shall be provided.

CLAUSE NO.	TECHNICAL REQUIREMENTS
	(vi) Protection Class — IP: 55 minimum for indoor & IP-65 minimum for outdoor applications. (vii) Grounding — To be provided. (viii) Color — To be decided during detailed engineering & subject to Employer's approval.
10.00.00	**CONDUITS**
10.01.00	Conduits shall be generally used for interconnecting cables from field instruments to Local JB's. All rigid conduits, couplings and elbows shall be hot dipped galvanised rigid mild steel in accordance with IS: 9537 Part-I (1980) and Part-II (1981). The conduit interior and exterior surfaces shall have continuous zinc coating with an overcoat of transparent enamel lacker or zinc chromate. Flexible conduit shall be heat resistant lead coated steel, water leak, fire and rust proof. The temperature rating of flexible conduit shall be suitable for application areas. For remaining applications, water leak, fire & rust proof flexible C.I conduits shall be provided.
10.02.00	The Bidder shall install conduits according to the general routing as approved by Employer and shall coordinate conduit locations with other works.
10.03.00	All grounding bushings within all enclosures shall be wired together and connected internally to the enclosure grounding lug or grounding bus with 8 AWG bare copper conductor. Conduit runs to individually mounted equipment shall be grounded to the Employer's cable tray grounding conductor with 12 AEG bare copper conductor. All grounding bushings, clamps and connectors shall be subject to approval of the Employer.
10.04.00	All rigid conduit fittings shall conform to the requirements of IS: 2667, 1976. Galvanized steel fitting shall be used with steel conduit. All flexible conduit fittings shall be liquid tight, galvanized steel. The end fittings shall be compatible with the flexible conduit supplied.
10.05.00	All individually mounted equipment and devices shall be connected to the supply conduit, using not more than one meter of flexible conduit adjacent to the equipment or device. Flexible conduit shall be installed in all conduit runs, which are supported by both building steel and structures subject to vibration or thermal expansion. This shall include locations where conduit supported by building steel enters or becomes supported by the turbine generator foundation and where conduit supported by building steel or foundation becomes supported by steam generator framing.
10.06.00	Special areas, such as control rooms in which external noise is to be minimized, shall have flexible conduit in conduit runs where the runs cross from the main building framing to the control room framing.
10.07.00	Conduit supports shall be furnished and installed in accordance with these specifications. Support material shall comply with the following requirements. i) Hanger rods shall be 12 mm diameter galvanized threaded steel rods. ii) Single conduit supports shall be one-hole cast metal straps and clamp backs unless other types are acceptable to the Employer. Multiple conduit bank

CLAUSE NO.	TECHNICAL REQUIREMENTS
	supports shall be constructed of special galvanized support channels with associated conduit clips.
10.08.00	Conduit sealing, explosion proof, dust proof and other types of special fittings shall be provided as required by these specifications and shall be consistent with the area and equipment with which they are installed. Fittings installed outdoors and in damp locations shall be sealed and gasketed. Hazardous area fittings and conduits sealing shall conform to NEC requirements for the area classification.
10.09.00	Contractor shall provide double locknuts on all conduit terminations not provided with threaded hubs and couplings. Water tight conduit unions and rain tight conduit hubs shall be utilised for all the application which shall be exposed to weather. Moisture pockets shall be eliminated from conduits.
10.10.00	Conduits shall be securely fastened to all boxes and cabinets.
11.00.00	**CABLE SUB-TRAY & SUPPORT**
11.01.00	The cable sub-trays and the supporting system, to be generally used between Local/Group JBs and the main cable trays and the same shall be furnished and installed by the Contractor. It is the assembly of sections and associated fittings forming a rigid structural system used to support the cable from the equipment or instrument enclosure upto the main cable trays (trunk route).
11.02.00	The covers on the cable sub-trays shall be used for protection of cables in areas where damage may occur from falling objects, welding spark, corrosive environment, etc. & shall be electrically continuous and solidly grounded. The cable trays shall not have sharp edges, burrs or projections injurious to the insulation or outer sheath of the cables.
11.03.00	The supporting arrangement of cable tray system shall be able to withstand the weight of the cable and cable tray system. The supporting interval shall not be more than the recommended span for the above loading for the type of cable tray selected. The tray shall not overhang by more than one meter from the support at the dead end. As far as practicable the cable sub-tray system shall be supported from one side only, in order to facilitate installation and maintenance of cables.
11.04.00	The Bidder shall furnish and install the estimated quantities and sizes of sub trays/troughs including all required fittings and adaptors on as required basis.
12.00.00	Following C & I drawings referred in this sub-section are enclosed herewith.

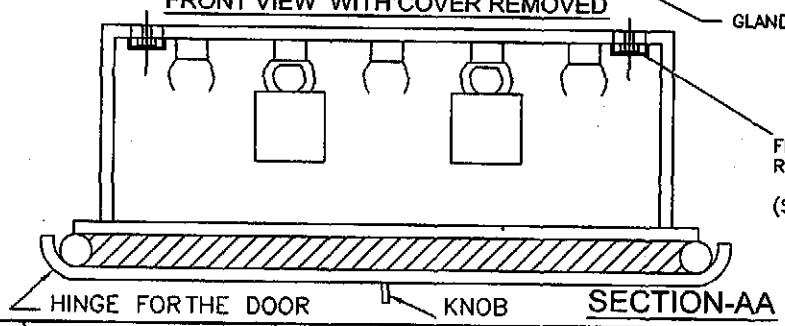
Sl. No.	Drawing No.	Sht Nos	Drawing Title
1	0000-999-POI-A-017	1	Local Junction box details
2	0000-999-POI-A-021	2	Instrumentation cabling philosophy
3	0000-999-POI-A-063	1	Interfacing of Actuator
4	0000-999-POI-A-065	1-14	Interfacing of field Instruments



A – 75 mm
B – 25 mm
C – SEE NOTE-4
D – 100 mm
E – 150 mm

NOTES:-

1. JUNCTION BOXES SHALL HAVE GLAND PLATES AT THE BOTTOM OF THE BOX ONLY.
2. TUBULAR TYPE GASKETS WILL BE USED.
3. FRP JUNCTION BOXES, SHALL BE PROVIDED WITH POLYEUTHERENE COATING. ALSO REFER SUB SECTION INST CABLE, PART-B SECTION-VI FOR DETAILES.
4. DIMENSION OF 'F' SHALL BE BASED ON NO. OF TERMINAL BLOCKS.
5. THE EXACT TYPE & DIMENSION OF JUNCTION BOXES TO BE USED FOR A PARTICULAR APPLICATION SHALL BE AS DECIDED DURING DETAIL ENGG. STAGE AND SHALL BE SUBJECT TO EMPLOYER's APPROVAL WITHOUT ANY PRICE REPERCUSSION.
6. THE KNOB FOR ALL THE JUNCTION BOXES SHALL BE IDENTICAL.
7. ANY TYPE OF SEALED FIXING ARRANGEMENT AS PER MANUFACTURER's STANDARD CAN ALSO BE PROVIDED SUBJECT TO EMPLOYER's APPROVAL.



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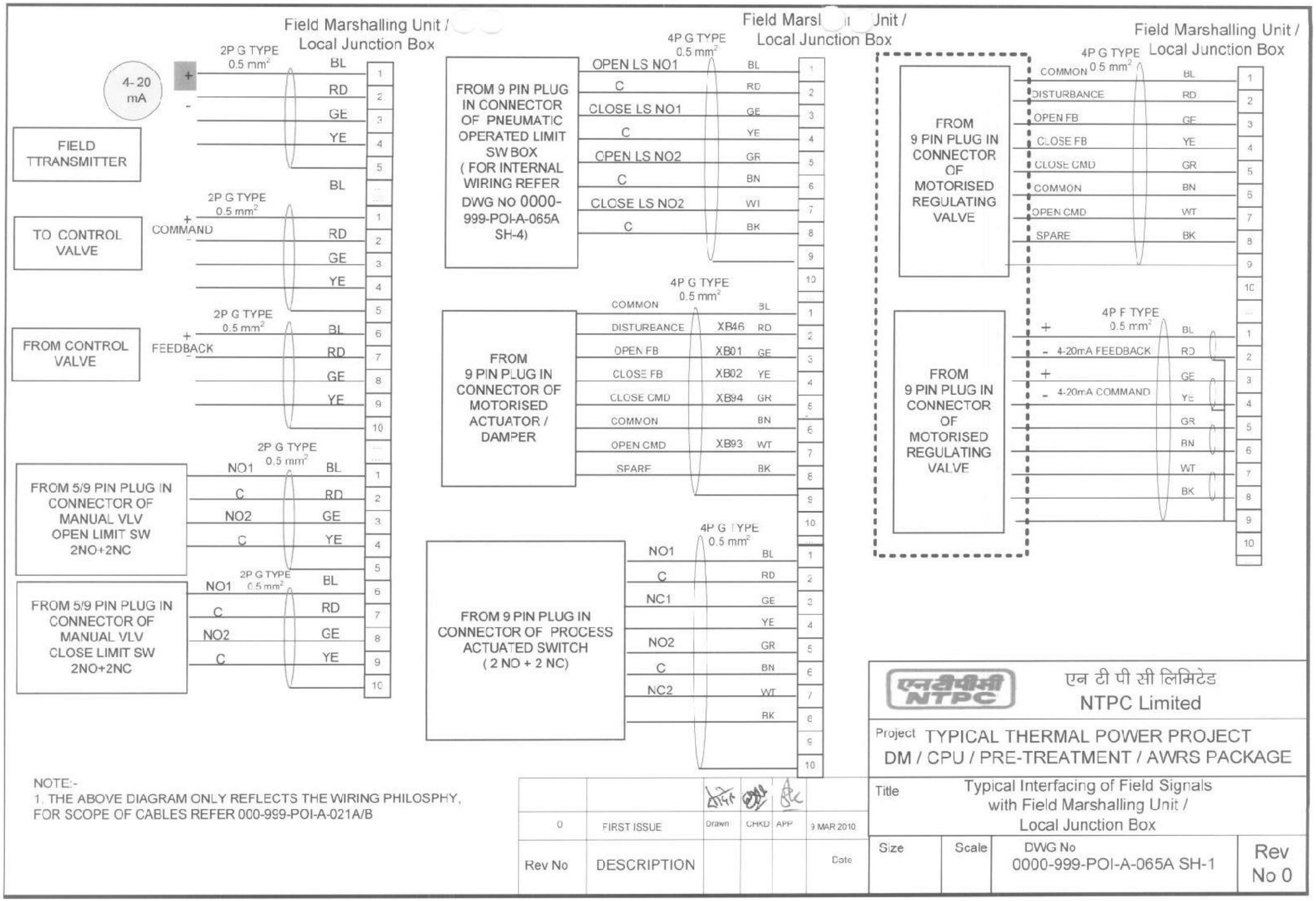
REV.NO.	DESCRIPTION	DRAWN	DESIGN	CHKD.	M	E	C	C&I	ARCH.	APPD	DATE
D	GENERALLY REVISED		JM	KS							30.11.05
C	GENERALLY REVISED		JM	KS							04.08.06
B	GENERALLY REVISED	S.K.	A.R	PS							
A	FIRST ISSUE	S.K.	A.R	PS							04.05.05

CLEARED BY

PROJECT: TYPICAL THERMAL POWER PLANT

TITLE: LOCAL JUNCTION BOX CONNECTION DETAILS

SIZE	SCALE	DRG. NO.	REV. NO.
A3	N.T.S.	0000-999-POI-A-017	D



NOTE:-
1. THE ABOVE DIAGRAM ONLY REFLECTS THE WIRING PHILOSPHY, FOR SCOPE OF CABLES REFER 000-999-POI-A-021A/B

Rev No	DESCRIPTION	Drawn	CHKD	APP	Date
0	FIRST ISSUE				9 MAR 2010

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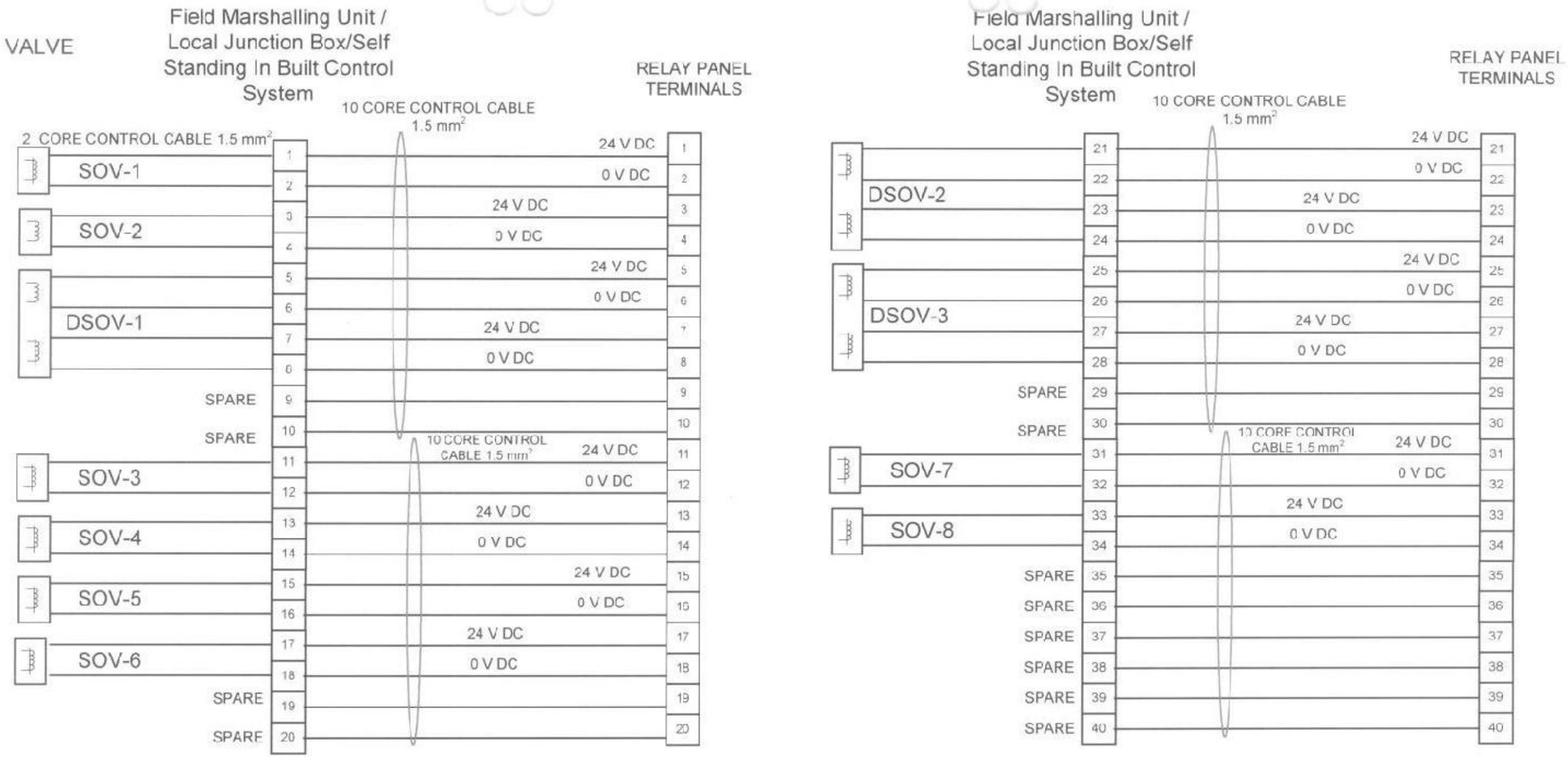
NTPC Limited

Project: TYPICAL THERMAL POWER PROJECT
DM / CPU / PRE-TREATMENT / AWRS PACKAGE

Title: Typical Interfacing of Field Signals with Field Marshalling Unit / Local Junction Box

Size	Scale	DWG No	Rev No
		0000-999-POI-A-065A SH-1	0



NOTE:-
1. THE ABOVE DIAGRAM ONLY REFLECTS THE WIRING PHILOSPHY, FOR SCOPE OF CABLES REFER 000-999-POI-A-021A/B

Rev No	DESCRIPTION	Drawn	CHKD	APP	Date
0	FIRST ISSUE				9 MAR 2010

एन टी पी सी लिमिटेड
NTPC Limited

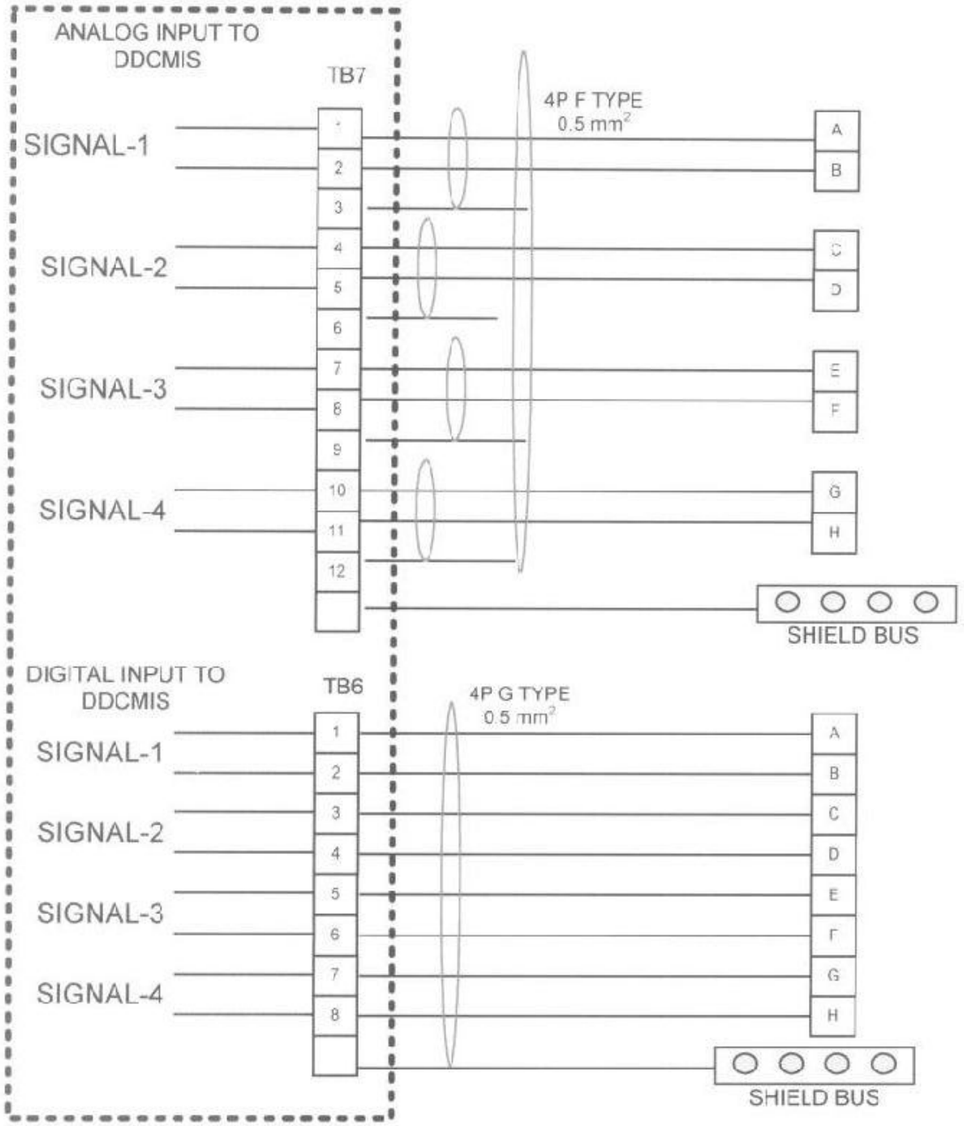
Project: TYPICAL THERMAL POWER PROJECT
DM / CPU / PRE-TREATMENT / AWRS PACKAGE

Title: Typical Interfacing of Field Signals with Field Marshalling Unit / Local Junction Box

Size	Scale	DWG No	
		0000-999-POI-A-065A SH-2	REV-0

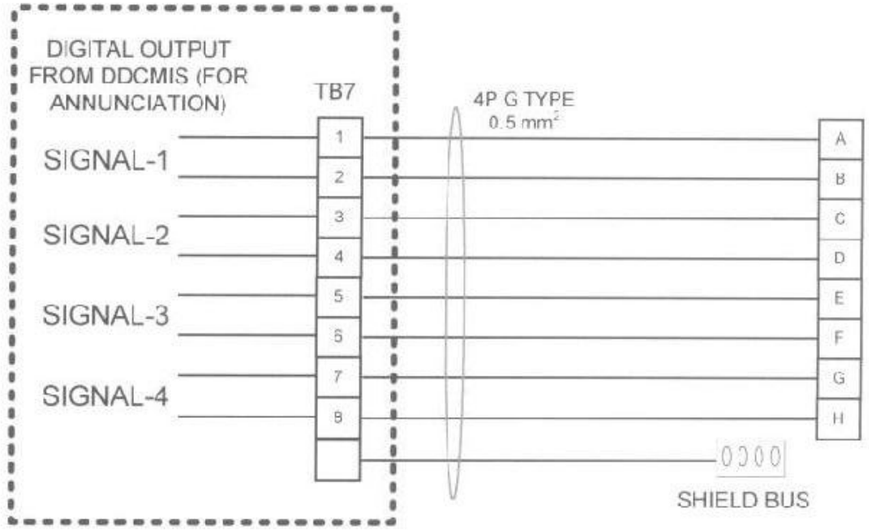
SELF STANDING IN BUILT CONTROL SYSTEM

MARSHALLING CABINET OF DDCMIS



SELF STANDING IN BUILT CONTROL SYSTEM

MARSHALLING CABINET OF DDCMIS



NOTE:-
1. THE EXACT TB TERMINATION DETAILS OF SELF STANDING IN BUILT CONTROL SYSTEM PANEL FOR INTERFACING WITH DDCMIS WILL BE PROVIDED BY EMPLOYER
2. THE ABOVE DIAGRAM ONLY REFLECTS THE WIRING PHILOSPHY, FOR SCOPE OF CABLES REFER 000-999-POI-A-021A/B

Rev No	DESCRIPTION				Date
0	FIRST ISSUE	Drawn	CHKD	APP	9 MAR 2010

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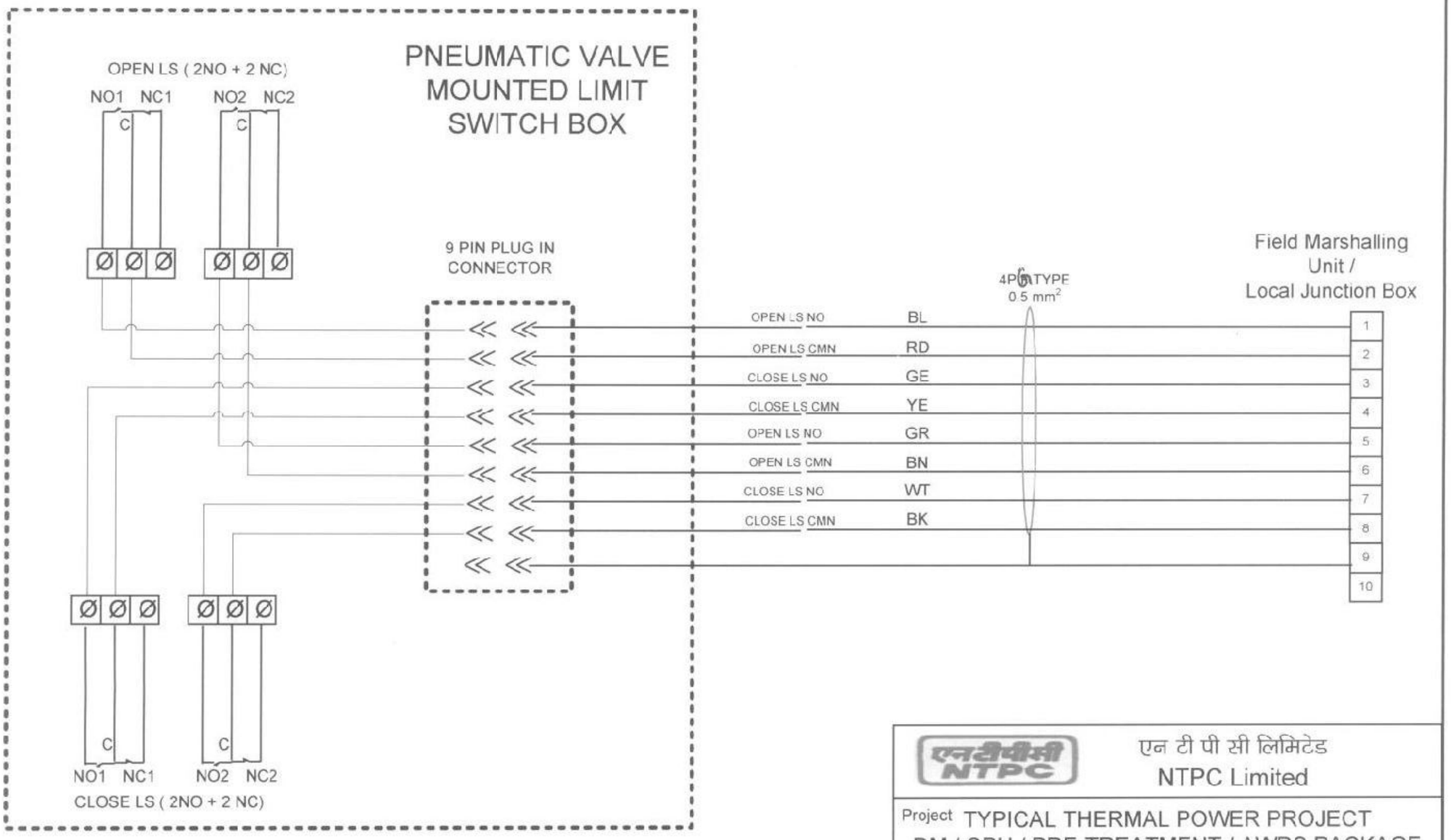
NTPC Limited

Project: TYPICAL THERMAL POWER PROJECT
DM / CPU / PRE-TREATMENT / AWRS PACKAGE

Title: Typical Interfacing of Field Signals with Field Marshalling Unit / Local Junction Box

Size	Scale	DWG No	
		0000-999-POI-A-065A SH-3	REV-0



NOTE:-
1. THE ABOVE DIAGRAM ONLY REFLECTS THE WIRING PHILOSPHY, FOR SCOPE OF CABLES REFER 000-999-POI-A-021A/B

Rev No	DESCRIPTION	Drawn	CHKD	APP	Date
0	FIRST ISSUE				9 MAR 2010

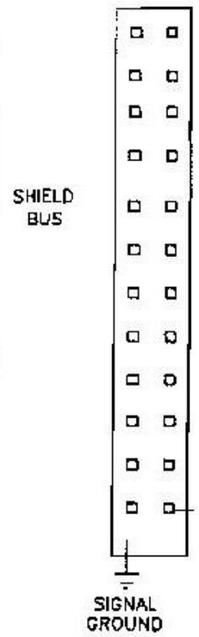
एन टी पी सी लिमिटेड
NTPC Limited

Project: TYPICAL THERMAL POWER PROJECT
DM / CPU / PRE-TREATMENT / AWRS PACKAGE

Title: Typical Interfacing of Field Signals with Field Marshalling Unit / Local Junction Box

Size	Scale	DWG No	Rev No
		0000-999-POI-A-065A SH-4	0

MARSHALLING/ TERMINATION CUBICLES — 4 PAIR, 0.5 Sq. mm — MCC/SWGR D



02	BL	04	
04	RD	06	Q, K3 — MCC DISTURBANCE
		05	K3, Q — MCC DISTURBANCE
		07	
06	GE	08	42a — STATUS 'ON'
08	YE	09	42b — STATUS 'OFF'
10	GR	01	K11 — COMMAND 'OFF'
12	BN	03	
14	WT	02	K12 — COMMAND 'ON'
16	BK		
		13	
		14	49 — OVERLOAD TRIP OPERATED FOR OTHER SYSTEMS (WHERE REQUIRED)
		15	
		17	
		16	EMERGENCY PUSH BUTTON OPERATED FOR OTHER SYSTEMS (WHERE REQUIRED)
		10	
		11	42 — STATUS ON/OFF FOR OTHER SYSTEMS (WHERE REQUIRED)
		12	42

NOTE

1. FOR CHP DRIVES, THE SCHEME SHALL BE FINALISED DURING DETAILED ENGG.

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NTPC LIMITED
(A GOVERNMENT OF INDIA ENTERPRISE)
ENGINEERING DIVISION

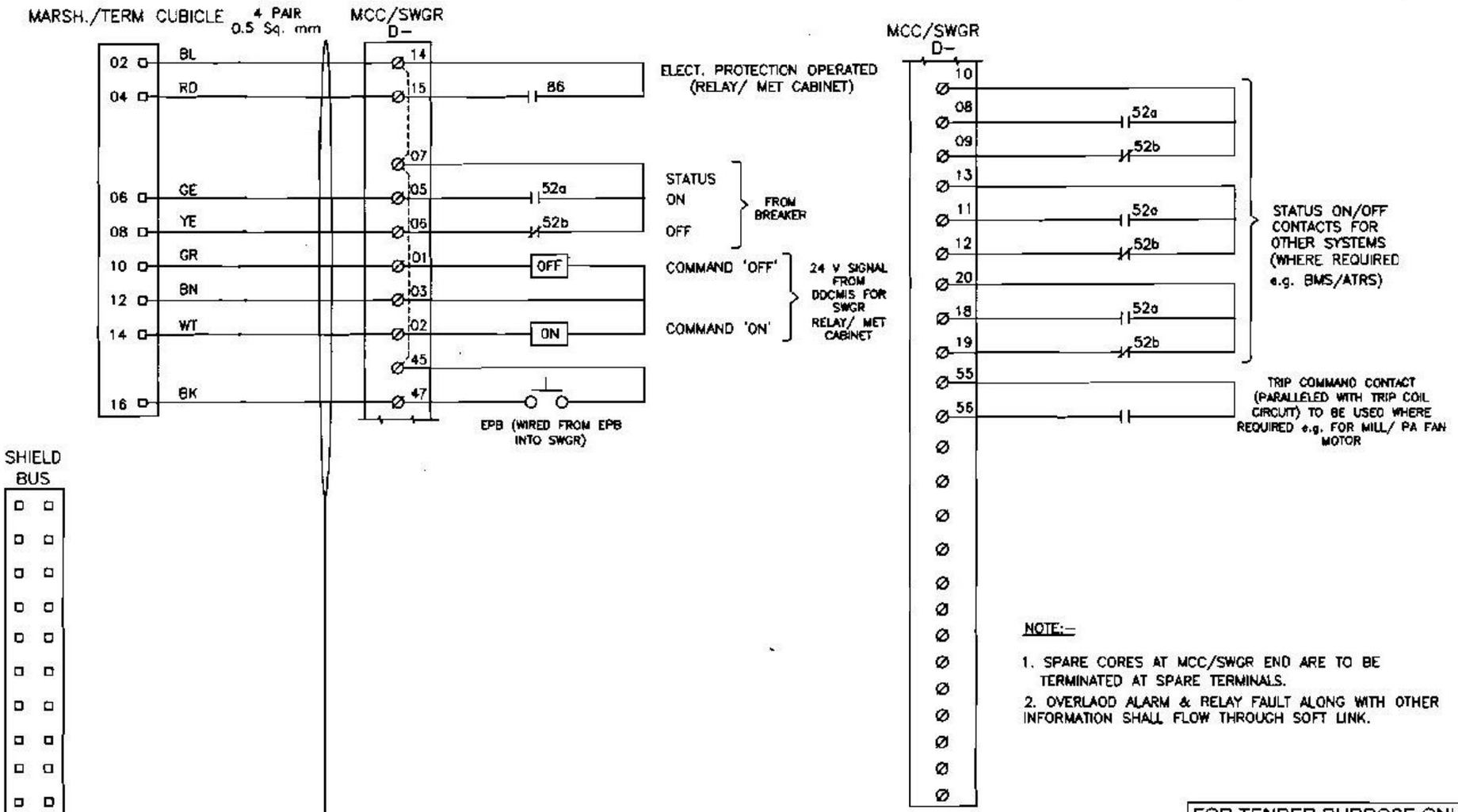
REV.NO.	DESCRIPTION	DRAWN	DESIGN	CHKD.	M	E	C	C&I	ARCH.	APPD	DATE
A	FIRST ISSUE										28.04.06

CLEARED BY

PROJECT: TYPICAL THERMAL POWER PROJECT

TITLE: INTERFACING OF FIELD INSTRUMENTS
INTERFACE OF DDCMIS WITH MCC/SWGR/ACTUATOR
(LT MOTORS)

SIZE	SCALE	DRG. NO.	REV. NO.
A3	NTS	0000-999-POI-A-065 SH 05 OF 14	A



NOTE:–

1. SPARE CORES AT MCC/SWGR END ARE TO BE TERMINATED AT SPARE TERMINALS.
2. OVERLAOD ALARM & RELAY FAULT ALONG WITH OTHER INFORMATION SHALL FLOW THROUGH SOFT LINK.

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NTPC LIMITED
(A GOVERNMENT OF INDIA ENTERPRISE)
ENGINEERING DIVISION

PROJECT: TYPICAL THERMAL POWER PROJECT

TITLE: INTERFACING OF FIELD INSTRUMENTS
INTERFACE OF DDCMIS WITH MCC/SWGR/ACTUATOR
(HT MOTORS)

REV.NO.	DESCRIPTION	DRAWN	DESIGN	CHKD.	M	C	C&I	ARCH.	APPD	DATE
B	Revised for Numerical relay based SWGR				CLEARED BY					14.02.08

SIZE	SCALE	DRG. NO.	REV. NO.
A3	NTS	0000-999-POI-A-065 SH 07 OF 14	B

ANNEXURE-I

ANNEXURE-1

Clause 9.00.00 - Specification for ULTRASONIC TYPE LEVEL TRANSMITTER:

S.No.	Features	Essential/Minimum requirement
1.	Type of Transmitter	Non contact Microprocessor based 2 wire type, HART protocol compatible Ultrasonic transmitter.
2.	Output signal	4-20 mA DC (Analog) along with superimposed digital signal (based on HART protocol)
3.	Sensor Accuracy	+/- 0.5% of calibrated span.
4.	Sensor Repeatability	3mm or better.
5.	Power supply	24 V DC +/-10%.
6.	Temperature compensation	To be provided within transducer.
7.	Configuration	
8.	Housing	Weather proof as per IP-55 with durable corrosion resistance coating.
9.	Adjustment/calibration/ maintenance	From hand held calibrators/centralized PC based system (as applicable).
10.	Zero and Span adjustment	Continuous, tamper proof, remote as well as manual to calibrate the instrument without any level in the tank/sump etc.
11.	Sensor Material	Corrosion resistant material to suit individual application requirement.
12.	False signal tolerance	Transmitter shall e capable of ignoring false echoes from internal tank/sumps obstructions such as pipes, heating coils or agitator blades. Also transmitter shall have adjustable damping circuitry.
13.	Range	Range of transmitter shall be capable of covering the complete level span of tank taking care of blocking distance, frequency attenuation due to surface, obstructions, vapors etc.

ANNEXURE-1

14.	Display	LCD display with integral keypad to be provided.
15.	Diagnostics	Loss of echo alarm etc.
16.	Load Impedance	500 ohms minimum
17.	Electrical Connection	Plug and socket
18.	Accessories	• All weather canopy for protection from direct sunlight and direct rain. • All mounting hardware and accessories required for erection and commissioning mounting fittings materials shall be SS 316. • For hazardous area, explosion proof enclosure as described in NEC article 500

Note:

1) Contractor can also provide Radar type transmitter in place of ultrasonic transmitters subject to approval by Employer during detailed Engineering. Sonic frequency based transmitters can also be provided under "ultrasonic transmitters" category for solid / viscous applications e.g. ash silo level etc.

2) The frequency used for Ultrasonic /sonic measurements shall be suitable for envisaged applications and this shall be supported by the standard product catalogue of the instrument manufacturer.

PART – B

SUB-SECTION – IIIC-07

TYPE TEST REQUIREMENTS (C&I)

CLAUSE NO.	TECHNICAL REQUIREMENTS
	TYPE TEST REQUIREMENTS (CONTROL & INSTRUMENTATION)
1.00.00	**GENERAL REQUIREMENTS**
1.01.00	The Contractor shall furnish the type test reports of all type tests as per relevant standards and codes as well as other specific tests indicated in this specification. A list of such tests are given for various equipment in table titled 'TYPE TEST REQUIREMENT FOR C&I SYSTEMS' at the end of this sub-section. For the balance equipment instrument, type tests may be conducted as per manufactures standard or if required by relevant standard. (a) Out of the tests listed, the Bidder/ sub-vendor/ manufacturer is required to conduct certain type tests specifically for this contract (and witnessed by Employer or his authorized representative) even if the same had been conducted earlier, as clearly indicated subsequently against such tests. (b) For the rest, submission of type test results and certificate shall be acceptable provided. i) The same has been carried out by the Bidder/ sub-vendor on exactly the same model /rating of equipment. ii) There has been no change in the components from the offered equipment & tested equipment. iii) The test has been carried out as per the latest standards alongwith amendments as on the date of Bid opening. (c) In case the approved equipment is different from the one on which the type test had been conducted earlier or any of the above grounds, then the tests have to be repeated and the cost of such tests shall be borne by the Bidder/ sub-vendor within the quoted price and no extra cost will be payable by the Employer on this account.
1.02.00	As mentioned against certain items, the test certificates for some of the items shall be reviewed and approved by the main Bidder or his authorized representative and the balance have to be approved by the Employer.
1.03.00	The schedule of conduction of type tests/ submission of reports shall be submitted and finalized during pre-award discussion.
1.04.00	For the type tests to be conducted, Contractor shall submit detailed test procedure for approval by Employer. This shall clearly specify test setup, instruments to be used, procedure, acceptance norms (wherever applicable), recording of different parameters, interval of recording precautions to be taken etc. for the tests to be carried out.
1.05.00	The Bidder shall indicate in the relevant Bid schedule, the cost of the type test for each item only for which type tests are to be conducted specifically for this project.

CLAUSE NO.	TECHNICAL REQUIREMENTS

The cost shall only be payable after conduction of the respective test. If a test is waived off, then the cost shall not be payable.

2.00.00 **Special Requirement for Solid State Equipments/ systems**

2.02.00 The minimum type test reports, over and above the requirements of above clause, which are to be submitted for each of the major C&I systems, various PLCs etc. shall be as indicated below:

i) Surge Protections for Solid State Equipments/ Systems

All solid state systems/ equipments shall be able to withstand the electrical noise and surges as encountered in actual service conditions and inherent in a power plant. All the solid state systems/ equipments shall be provided with all required protections that needs the surge withstand capability as defined in ANSI 37.90a/ IEEE-472. Hence, all front end cards which receive external signals like Analog input & output modules, Binary input & output modules etc. including power supply, data highway, data links shall be provided with protections that meets the surge withstand capability as defined in ANSI 37.90a/IEEE-472. Complete details of the features incorporated in electronics systems to meet this requirement, the relevant tests carried out, the test certificates etc. shall be submitted along with the proposal. As an alternative to above, suitable class of IEC-255-4 which is equivalent to ANSI 37.90a/ IEEE-472 may also be adopted for SWC test.

ii) Dry Heat test as per IEC-68-2-2 or equivalent.

iii) Damp Heat test as per IEC-68-2-3 or equivalent.

iv) Vibration test as per IEC-68-2-6 or equivalent.

v) Electrostatic discharge tests as per EN 61000-4-2 or equivalent.

vi) Radio frequency immunity test as per EN 50082-2 or equivalent.

vii) Electromagnetic immunity as per EN 61131-2 or equivalent.

Test listed at item no. (v), (vi), (vii) above are applicable for front end cards only as defined under item (i) above.

3.00.00 TYPE TEST REQUIREMENT FOR C&I SYSTEMS

Sl no	**Item**	**Test requirement**	**Standard**	**Test to be specifically conducted**	**NTPC's approval required on test certificate**
Col 1	**Col 2**	**Col 3**	**Col 4**	**Col 5**	**Col 6**
1	Narrow chart recorder	As per standard in Col 4	IS9319	No	No

CLAUSE NO.	TECHNICAL REQUIREMENTS

Sl no	Item	Test requirement	Standard	Test to be specifically conducted	NTPC's approval required on test certificate
Col 1	Col 2	Col 3	Col 4	Col 5	Col 6
2	Multi point recorder	As per standard in Col 4	IS9319	No	No
3	Vertical indicators	As per standard in Col 4	IS9319	No	No
4	Elect. Metering instruments	As per standard in Col 4	IS-1248	No	Yes
5	Thermocouple	Degree of protection test	IS-2147	No	No
6	RTD	As per standard in Col 4	IEC-751	No	No
7	C.J.C.BOX	Degree of protection test	IS-2147	No	Yes
		Ambient Temp. effect	Approved procedure	No	Yes
8	Electronic transmitter	As per standard in Col 4	BS-6447/ IEC-770	No	Yes
9	E/P converter / Smart Positioner	As per standard in Col 4	Mfr. standard	No	Yes
10	INSTRUMENTATION CABLES TWISTED & SHIELDED			No	Yes
	a) Conductor	Resistance test	VDE-0815		
		Diameter test	IS-10810		
		Tin Coating test (drain wire)			
	b) Insulation	Loss of mass	VDE 0472		
		Aging in air ovens	VDE 0472**		
		Tensile strength and elongation	VDE 0472**		
		Heat shock	VDE 0472**		
		Hot deformation	VDE 0472		
		Shrinkage	VDE 0472		
		Bleeding & blooming	IS-5831		
	c) Inner sheath	Loss of mass	VDE 0472		
		Heat shock	VDE 0472**		
		Cold bend/ cold impact test	IS-5831		
		Hot deformation	VDE 0472		
		Shrinkage	VDE 0472		
	d) Outer sheath	Loss of mass	VDE 0472		
		Aging in air ovens	VDE 0472**		

CLAUSE NO.	TECHNICAL REQUIREMENTS

Sl no	Item	Test requirement	Standard	Test to be specifically conducted	NTPC's approval required on test certificate
Col 1	**Col 2**	**Col 3**	**Col 4**	**Col 5**	**Col 6**
		Tensile strength and elongation test before and after ageing	VDE 0472**		
		Heat shock	VDE 0472**		
		Hot deformation	VDE 0472		
		Shrinkage	VDE 0472		
		Bleeding & blooming	IS-5831		
		Colour fastness to water	IS-5831		
		Cold bend/ cold impact test	IS-5831		
		Oxygen index test	ASTMD-2863		
		Smoke Density Test	ASTMD-2843		
		Acid gas generation test	IEC-754-1		
	e) Fillers	Oxygen index test	ASTMD-2863		
		Smoke Density Test	ASTMD-2843		
		Acid gas generation test	IEC-754-1		
	f)AL-MYLAR shield	Continuity test			
		'Shied thickness			
		Overlap test			
		Noise interference	IEEE Transactions		
	g)Over all cable	Flammability	IEEE 383		
		Noise interference			
		Dimensional checks	IS 10810		
		Cross talk			
		Mutual capacitance	VDE-0472		
		HV test	VDE-0472		
		Drain wire continuity			
11	Pressure gauge	Degree of protection test	IS-2147	No	No
		Temp interference test	IS -3624	No	No

CLAUSE NO.	TECHNICAL REQUIREMENTS

Sl no	Item	Test requirement	Standard	Test to be specifically conducted	NTPC's approval required on test certificate
Col 1	Col 2	Col 3	Col 4	Col 5	Col 6
12	Temperature gauge	Degree of protection test	IS-2147	No	No
13	Pressure & DP switch	Degree of protection test	IS-2147	No	No
		As per standard (col 4)	BS 6134	No	No
14	Level switch	Degree of protection test	IS-2147	No	No
15	Control valves	CV Test	ISA 75.02	NO	NO
16	Flow Nozzles & Orifice plate	Calibration	ASME PTC , BS 1042	No	NO
18	Junction Box	Degree of protection test	IS-2147	No	Yes

PART – B

QUALITY ASSURANCE

SUB-SECTION – IIIE-15

MEASURING INSTRUMENTS

(PRIMARY AND SECONDARY)

MEASURING INSTRUMENTS (PRIMARY AND SECONDARY)

TESTS / ITEMS	Dimensions (R)	Make, Model, Type, Rating (R)	Process / Electrical connection (R)	Calibration (R)	Test as per standard(R)	Insulation Resistance (R)	IBR Certification (if applicable)(R)	Hydro Test(R)	Material Test certificate ®
1. PR Gauge (IS-3624)	Y	Y	Y	Y	Y				
2. Temp. Gauge (BS-5235)	Y	Y	Y	Y	Y				
3. Pr./D.P.Switch(BS-6134)	Y	Y	Y	Y	Y	Y			
4. Electronic Transmitter(IEC-770)	Y	Y	Y	Y	Y	Y			
5. Temp. Switch	Y	Y	Y	Y	Y	Y			
6. Recorder(IS-9319/ANSI C-39.4)	Y	Y	Y	Y	Y	Y			
7. Vertical indicators	Y	Y	Y	Y		Y			
8. Digital Indicators	Y	Y	Y	Y		Y			
9. Integrators	Y	Y	Y	Y					
10. Electrical Metering Instrument (IS-1248)	Y	Y	Y	Y	Y	Y			
11. Transducer (IEC-688)	Y	Y	Y	Y	Y	Y			
12. Thermocouples (ANSI-MC-96.1)	Y	Y	Y	Y	Y	Y			
13. RTD(IEC-751)	Y	Y	Y	Y	Y	Y			
14. Thermowell	Y		Y				Y	Y	Y

R-Routine Test A- Acceptance Test Y – Test applicable

: Note: 1) Detailed procedure of Environmental Stress Screening shall be as per Quality Assurance Programme in General Technical Conditions

2) This is an indicative list of tests/checks. The manufacturer is to furnish a detailed quality plan indicating the Practices and Procedure adopted alongwith relevant supporting documents.

TESTS / ITEMS	Dimensions (R)	Make, Model, Type, Rating (R)	Process / Electrical connection (R)	Calibration (R)	Requirement as per standard (R)	WPS approval (A)	Non-destructive testing (R)	Calculation for accuracy (R)	Insulation Resistance (R)	IBR Certification as applicable (R)	Hydro test (R)	Material test certificate (A)
15. Cold junction compensation box	Y	Y	Y	Y					Y			
16. Orifice plate(BS-1042)	Y	Y	Y	Y *	Y	Y **	Y **			Y	Y **	Y
17. Flow nozzle(BS-1042)	Y	Y	Y	Y *	Y	Y	Y			Y	Y	Y
18. Impact head type element	Y	Y	Y					Y				Y
19. Level transmitter/float type switch	Y	Y	Y	Y					Y	Y	Y	Y
20. Flue Gas analyser	Y	Y	Y	Y								
21. Dust emission monitors	Y	Y	Y	Y								
*Calibration to be carried out on one flow element of each type and size if calibration carried out as type test same shall not be repeated.												
** If applicable												
R-Routine Test A- Acceptance Test Y – Test applicable												

Note: 1) Detailed procedure of Environmental Stress screening test shall be as per Quality Assurance Programme in General Technical Conditions

2) This is an indicative list of tests/checks. The manufacturer is to furnish a detailed quality plan indicating the Practices and Procedure adopted along with relevant supporting documents.

3) APPLICABLE AS OPER SCOPE OF SUPPLY

PART – B

QUALITY ASSURANCE

SUB-SECTION – IIIE-16

PROCESS CONNECTION AND PIPING

PROCESS CONNECTION AND PIPING

TESTS / ITEMS	Visual ®	GA, BOM, Layout of component & construction feature®	Dimension ®	Paint Shade/thickness ®	Flattening,flaring,hydrotest,hardness check as per ASTM standard (A)	Component Ratings ®	Wiring ®	Make, Model, Type, Rating®	IR & HV ®	Review of TC for instrument/devices (R)	Accessability of TBs/Devices ®	Illumination,grounding ®	Tubing ®	Leak/Hydro test(A)	Chemical/physical properties of material (A)	Proof pressure test,Dismantling & reassembly test,Hydrulic impulse and vibration test (R)	Tests as per standards & specification
Local Instrument enclosure	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y			
Local instruments racks	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y			
Junction Box	Y	Y	Y	Y*		Y		Y	Y								
Gauge Board	Y	Y	Y	Y		Y		Y		Y			Y	Y			
Impulse pipes and tubes	Y		Y		Y			Y							Y		
Socket weld fittings ANSI B-16.11	Y		Y					Y							Y		Y
Compression fittings	Y		Y					Y						Y	Y	Y	
Instrument valves & Valve manifolds	Y		Y					Y						Y	Y		
Copper tubings ASTM B75	Y							Y									Y

*-applicable for painted junction boxes.
Note: R-Routine Test A- Acceptance Test Y – Test applicable
Note: This is an indicative list of tests/checks. The manufacturer is to furnish a detailed quality plan indicating the Practices and Procedure adopted alongwith relevant supporting documents.

PART – B

QUALITY ASSURANCE

SUB-SECTION – IIIE-17

INSTRUMENTATION CABLES

QUALITY ASSURANCE

INSTRUMENTATION CABLE

TESTS / ITEMS	Conductor Resistance ® & (A)	High Voltage ® & (A)	Insulation Resistance ® & (A)	Constructional detail, dimensions (A)	Outer-Sheathe/core marking, end sealing (A)	Thermal Stability (A) +	Visual, Surface finish (A) +	Electrical Parameters ** (A) +	Persulphate Test (A) +	Overall/Coverage/Continuity (A)	Swidesh chimney Test (SS-4241475) (A) ++	FRLS Test * (A) ++	Tensile & Elongation before & after aging (A) ++	Vol. Resistivity. at room & Elevated Temp. (A) ++	Spark test report review ®
1. Instrument cable twisted and shielded															
Conductor(IS-8130)	Y			Y			Y								
Insulation(VDE-207)				Y	Y	Y	Y						Y		Y
Pairing/Twisting				Y	Y		Y								
Shielding				Y			Y			Y					
Drain wire	Y			Y			Y		Y	Y					
Inner Sheath				Y	Y	Y	Y					Y	Y		
Outer Sheath				Y	Y	Y	Y					Y	Y		
Over all cable	Y	Y	Y	Y	Y		Y	Y			Y			Y	
Cable Drums(IS-10418)				Y			Y								

Note : High Temp. cables shall be subjected to tests as per VDE-207(Part-6) Compensating cables shall be checked for Thermal EMF/Endurance test as per IS 8784.

Note : This is an indicative list of tests/checks. The manufacture is to furnish a detailed Quality Plan indicating his practice & Procedure along with relevant supporting documents during QP finalization for all items.

Note : ® - Routine Test A - Acceptance Test Y - Test Applicable

Note : Sampling Plan for Acceptance test shall be as per IS 8784 (As applicable)

- * FRLS Tests: Oxygen / Temp Index (ASTM D-2863), Smoke Density Rating (ASTM – D 2843), HCL Emission (IEC-754-1)
- ** Characterisitic Impedence, Attenuation, Mutual Capacitance, Cross Talk (As applicable)

\+ Sample size will be One No. of each size/type per lot.

++ Sample size will be One No. sample for complete lot offered irrespective of size/type.

PART – B

QUALITY ASSURANCE

SUB-SECTION – IIIE-02

MOTOR

MOTOR

TESTS/CHECKS / TEMS/COMPONENTS	Visual	Dimensional	Make/Type/Rating /General Physical Inspection	Mech/Chem. Properties	NDT /DP/MPI/UT	Metallography	Electrical Characteristics	Welding/Brazing(WPS/PQR)	Heat Treatment	Magnetic Characteristics	Hydraulic/Leak/Pressure Test	Thermal Characteristics	Run out	Dynamic Balancing	Routine & Acceptance tests as per IS-325/IS-4722 /IS- 9283/IS 2148/IEC60034\IEC 60079-I/ IS-12615	vibration	Over speed	Tan delta, shaft voltage & polarization index test	Paint shade, thickness & adhesion
Plates for stator frame, end shield, spider etc.	Y	Y	Y	Y	Y				Y										
Shaft	Y	Y	Y	Y	Y	Y			Y										
Magnetic Material	Y	Y	Y	Y			Y			Y		Y							
Rotor Copper/Aluminium	Y	Y	Y	Y			Y		Y										
Stator copper	Y	Y	Y	Y			Y		Y			Y							
SC Ring	Y	Y	Y	Y	Y		Y	Y	Y										
Insulating Material	Y		Y	Y			Y					Y							
Tubes, for Cooler	Y	Y	Y	Y	Y				Y		Y								
Sleeve Bearing	Y	Y	Y	Y	Y				Y		Y								
Stator/Rotor, Exciter Coils	Y	Y	Y				Y	Y											
Castings, stator frame, terminal box and bearing housing etc.	Y	Y	Y	Y	Y			Y											
Fabrication & machining of stator, rotor, terminal box	Y	Y			Y			Y	Y										
Wound stator	Y	Y					Y	Y											
Wound Exciter	Y	Y					Y	Y											
Rotor complete	Y	Y					Y						Y	Y					

Exciter, Stator, Rotor, Terminal Box assembly	Y	Y					Y												
Accessories, RTD, BTD,CT, Space heater, antifriction bearing, gaskets etc.	Y	Y	Y																
Complete Motor	Y	Y	Y												Y	Y	Y	Y1	Y

Note: 1. This is an indicative list of tests/checks. The manufacture is to furnish a detailed Quality Plan indicating the practices & Procedure followed along with relevant
supporting documents during QP finalization. However, No QP for LT motor upto 50KW.
2. Additional routine tests for Flame proof motors shall be applicable as per relevant standard
3. Makes of major bought out items for HT motors will be subject to NTPC approval.
4. Y1 = for HT Motor / Machines only.