

VOLUME – 2, SECTION – C
TECHNICAL SPECIFICATION
CONTROL AND INSTRUMENTATION

For

Renovation & Modernization

of

Boiler # 1 (220 TPH) of BPSCL



Prepared and submitted by:

steag

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MARCH 2017

PROJECT NO.: ETRM012	PROJECT NAME: Boiler # 1 (220 TPH)	PACKAGE / SYSTEM: STEAM GENERATOR & AUXILIARIES (C&I)
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REVISIONS

04	08.03.2017	BPSCL	BPSCL	BPSCL
03	05.06.2014	V Khare	M Agarwal	Sanjay Patel
02	26.11.2013	V Khare	M Agarwal	Sanjay Patel
01	12.08.2013	V Khare	M Agarwal	Sanjay Patel
00	31.08.2012	V Khare	A Vyas	G Sarkar
Revision	Date	Prepared by	Checked by	Approved by

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1.0 INTRODUCTION

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INTRODUCTION

Bokaro Power Supply Company Pvt. Ltd. (**BPSCL**) established in 2001 a Joint Venture Company of Steel Authority of India Ltd. (**SAIL**) and Damodar Valley Corporation (**DVC**) and is engaged in power and steam generation and supplies power and steam (at various pressures) to SAIL's Bokaro Steel Plant (**BSL**) located at Bokaro for meeting the process requirement of **BSL**.

The **Plant has 8 boilers** (5 boilers each of 220 **TPH** and 3 boilers each of 260 **TPH** capacity) and 6 turbine generators (one 12 MW back Pressure Turbine Generator (**TG**), 2 **TGs** each of 55MW capacity and 3 **TGs** each of 60 MW capacity).

1.1 LIST OF ABBREVIATIONS

BFP	Boiler Feed water Pump
CBD	Continuous Blow Down
CLCS	Closed Loop Control System
ESP	Electro Static Precipitator
EWS	Engineering Work Station
BMS	Burner management system
HEA	High Energy pulsed Arc
HP	High pressure
IBD	Intermittent Blow Down
IGV	Inlet Guide Vane
IPR	Inter Posing Relay
LRSB	Long Retractable Soot Blower
MSSV	Main Steam Safety Valve
OPC	Open Platform Communication (Object linked embedded Process Control)
OWS	Operator Working Station
PA	Primary Air
PRDS	Pressure Reducing De-superheating Station
PLC	Programmable Logic Controller
DDCMIS	Distributed Digital Control & Management Information System (also DCS)
SH	Super Heater
SWAS	Steam and Water Analyzer System
TFT	Thin Film Transistor
TC	Thermocouple
UPS	Uninterruptible Power Supply

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2.0 INTENT OF SPECIFICATION

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INTENT OF SPECIFICATION

The specifications intend to cover details of equipments & systems to be supplied and activities to be performed by the bidder for Control and Instrumentation system related to gas and oil firing management system with existing system for BPSCL Boiler No. 1 & its auxiliaries. However, any items / components / activities not specifically mentioned in this specification but required for completion of the project, shall be included in bidder's scope. The equipment shall conform in all respects to high standards of engineering, design and workmanship and be capable of performing in continuous commercial operation for the expected life extension of the plant after the R&M.

The general terms and conditions, instructions to bidders and other attachment referred to elsewhere are also to be considered as part of this tender specification. The bidder shall be responsible for and governed by all requirements stipulated in this section as well as all other section of tender specifications.

In case of conflict or contradiction between any two or more sections of this specification the more stringent condition shall be applicable. Owner, however, reserves the right to relax this condition at his discretion.

Bidder shall also need to consider the controls and instruments requirements as specified under the specifications for Steam generator & auxiliaries.

2.1 BASIC OBJECTIVE OF R&M OF CONTROL & INSTRUMENTATION SYSTEM

The major objective of R&M work for control & instrumentation are as follows:-

- Modernize the control & instrumentation systems of boiler with a PLC / DCS based system and implement the gas firing control, oil firing control, BMS logics, MFT Logics, protection, interlocks, existing C&I system measurements and analog auto / manual controls for steam generator & auxiliaries on the system.
- Employ state of the art I&C system for BPSCL Boiler -1& its auxiliaries.
- Achieve improved performance parameters of the unit as specified elsewhere in the specification.
- Extend unit life by 20 years of reliable operation.

The scope of Control & Instrumentation work to be carried out based on the following:

- Bidder to provide PLC / DCS system in which Bidder shall implement the Gas Firing Control, Oil Firing Control, BMS Logics, MFT Logics, protection, interlocks, etc., in line with tender specification.
- All signals which would be required to implement the above protection, logic and control, shall be initiated from new instrumentation. So, the required instruments, control valves, cable and accessories, etc., for the same shall be supplied, installed and commissioned by Bidder.
- Bidder shall also provide Control & Instrumentation as per process requirement and mentioned in Mechanical section of the tender.
- Supply and erection of C&I components & devices for existing system as per list given in Annexure -2.
- Moreover, Annexure-2 (of C&I specification) is for the existing C&I Bill of Quantity which has to be replaced with new ones and the same shall be operated from new PLC / DCS.
- I/O counts mentioned in Clause no. G in Annexure-2 is I/O list of existing C&I system and that has to be provided in the new PLC / DCS with implementation of all relevant measurements and existing controls.
- Bidder has to shift and implement five nos. of Auto Control Loops in new PLC / DCS. The same has been mentioned in tender as "Analog Auto / Manual Controls".

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2.2 GENERAL DESCRIPTION OF EXISTING CONTROL & INSTRUMENTATION SYSTEM

For BPSCL Boiler & auxiliaries # 1 to 5, existing station C&I system is George Kent make supplied by M/s Instrumentation limited Kota. Most of the control system is obsolete and spares are no longer available.

Existing Plant boiler control is performed through Relay based system. System is prone to errors due to contacts wear and tear.

Existing orifices & nozzles are suspected to be erroneous.

All control drives are motor operated.

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3.0 SCOPE OF WORK

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SCOPE OF WORK

The scope of work includes dismantling of existing Control & Instrumentation system and its R&M with PLC / DCS based system including transportation to Owner's workshop / stores as per Owner's guidance and engineering, design, manufacturing / procurement, assembly, inspection, supply, including transportation to site, unloading, storage and preservation at site, transportation from place of storage to erection site, erection, testing, pre-commissioning and commissioning of control & Instrumentation system and handing over in fully operational condition satisfactorily to Customer along with the supply of all consumables, tools & tackles, instruments, etc., and obtaining all statutory clearances.

The bidder has to collect any additional details from the site which is required for submitting the complete offer. In absence of the relevant drawings/documents, the bidder is advised to visit the site to get themselves fully conversant with the existing layout, existing I&C system, cut out details, existing impulse pipe condition, existing control & instrumentation cable condition, existing systems, control room layouts, foundation details, location, orientation, connections, wiring & termination details, earthing system, etc. & any other information/details required to complete the job.

3.1 DISMANTLING

Bidder's Scope of work shall also include dismantling of existing equipments which are rendered surplus or need replacement due to R&M work carried out under this package and depositing the dismantled equipment, materials etc. at the Owners designated place.

Bidder should also carry out all the work necessary to restore the plant/equipment/location to make it clean & workable in consultation with the Owner. All the equipments which are to be replaced shall be dismantled first. It is not the intent to describe all such work required to be done for dismantling/modifications herein, however a brief indicative list is given below:

- Existing control panel, all other cabinets/panels with associated cables in Unit Control Rooms, Control Equipment Rooms, and other places on Operating Floor & other floors.
- Existing Control Valves & actuators along with associated accessories, cables, tubing etc. as mentioned elsewhere in Technical Specification.
- Existing cables along with associated erection hardware such as trays, Junction box etc.
- Existing Local control panel, local instrument enclosures/racks/junction box/local panels with associated devices, cables, piping, tubing etc.
- Existing impulse pipes, fittings & trays etc.
- Existing motor operated and obsolete instruments along with tubing, piping, fittings and associated valves.
- All the transmitters, temperature elements, indicators and recorders presently installed but to be replaced as part of R&M to be handed over to the Owner for use as spares.
- Existing facia annunciation windows including cabling and related panels.
- Any Civil work required to dismantle and then erect the new system will be in the Bidder's scope.
- It shall be the Bidders responsibility to carryout Civil Work necessary to match the aesthetics of existing layout.

Any electrical / civil work necessary for successful completion and operation of complete functional I&C system is under bidder's scope.

3.2 SCOPE OF DESIGN, ENGINEERING & SUPPLY

The equipment and systems shall be designed and constructed to meet all specification requirements, and perform accurately and safely under the environmental and operating

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conditions described in this specification or implied, without undue heating, vibration, wear, corrosion or other operating troubles. It will be the responsibility of the Bidder to fully acquaint himself with the functional requirements and operating conditions, for equipment, systems and accessories of this project. Features / facilities shall be provided by the bidder where required to meet the service conditions and / functional or descriptive requirements stated in individual specification for these equipments/systems. The bidder shall develop various C&I engineering documentation and obtain approval from owner / consultant.

The scope of design, engineering & supply of Control & Instrumentation required for new gas firing / oil firing system and existing Control & Instrumentation system shall include, but not limited to, the following:

- The control shall preferably be designed on PLC / DCS based system with provision for inclusion of existing measurement, controls and protection (as listed in ANNEXURE – 2). The PLC / DCS system software shall be designed in such a way that it can handle 30% extra I/O tags. The I/O count for existing system is given in ANNEXURE – 2.
- Two number operating work station, one number operator cum engineering work station & one no. A4 (black & white) laser jet printer for each boiler in bidder's scope of supply.
- All measuring Instruments, field instruments, sensors, actuators, flow elements for BF / CO Gas / Oil firing. For existing system, the equipments will be supplied as per list given in ANNEXURE – 2.
- Flame/fire proof Instruments to be provided on the burner floor.
- Final control elements, control valves with actuators, on/off valves with actuators, power cylinders
 - Pneumatic actuator as per requirement for the successful operation of new BF / CO Gas / Oil firing system.
 - Replacement of 30 nos. existing electrical actuators (Please refer Annexure-2).
- Impulse pipes, tubing, fittings, instruments, valves, manifolds, isolating/drain valves, air supply pipes/ tubes, erection hardwire, Local instrument enclosure, local instrument rack, etc., as required for new gas firing and oil firing system. For existing system, the scope shall be as listed in Annexure-2 of C&I Section.
- MCC (motor control center) and cables required for any new electrical drives and MOVs(Motor operated valves).
- Supply of all consumables, tools and tackles, all start up and commissioning spares, instruments etc. and obtaining all statutory clearances.
- All control room panels, control desk, cabinets, power distribution panel, local push button stations, local control panel, modular control desk, furniture, etc., as required. Supply, laying & Termination of instrument & control cables, special cables, pre-fabricated cable, junction boxes, cable trays, cable tray covers, supports, cable glands, Lugs, ferrules, conduits, etc., (irrespective of the one end or both end in their scope) UPS & power supply distribution System (24 V DC for powering system and field instruments shall be provided by bidders and powered by UPS).
- Multi Fuel Flame scanners
- Hardwired Alarm Annunciation system with hooter for BMS
- Grounding and Earthing System
- Performance Test, Trial Operation and Guarantee Test
- Engineering documentation
- Spares
- Training of Owner's Personnel

Any other item/ instruments / equipment not covered herein but required for successful installation and commissioning of complete functional I&C system shall be included by the bidder in their scope.

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3.3 SCOPE OF ERECTION, TESTING & COMMISSIONING

Bidder shall erect, test and commission of all the above items in line with the relevant Sections of the specification. Sound engineering practice of international standard shall be adopted throughout.

3.4 TERMINAL POINTS

- Impulse Pipes: Root Valve. New valves and impulse lines shall be provided for all measurements related to oil and gas firing systems. For other existing area the same shall be renovated as per Annexure-2.
- Cabling: Input terminal of Switchgear/MCC for all cable coming from PLC / DCS & other existing controls, equipments etc. Glanding and termination at Switchgear / MCC input terminal by Bidder. Terminations at both ends shall be done by Bidder (irrespective of the one end or both ends in their scope). All termination from MCC / switchgear shall be established through interposing relays.
- Power supply connection to UPS, & non UPS distribution boards input terminals is under the Bidder's scope. (irrespective of the one end or both end in their scope)
- Any hardwired signals required for Boiler protection and its interfacing are under Bidder's scope (irrespective of the one end or both ends in their scope).

NOTE: The bidder shall provide complete specification of compressed air station along with required air flow capacity, air pressure, Motor rating etc. for operation of pneumatic actuated control valves and dampers.

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4.0 CONTROL PHILOSOPHY

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CONTROL PHILOSOPHY

The Steam Generators and auxiliaries shall be controlled and monitor from main control room for under all regimes of operation i.e. start-up, shutdown, normal operation, load maneuvering, load throw off & emergency handling.

Microprocessor based Boiler Management System (preferable on PLC / DCS platform) shall be operated, controlled & monitored through their dedicated operation work station for each Boiler. The control and automation system shall be suitably designed to achieve the plant performance and safety requirements.

4.1 RELIABILITY AND AVAILABILITY

Each component and system offered by the Bidder, like each electronic module/card, Power supply, Peripheral etc. shall have reliability to meet required mean time between failures (MTBF), meantime to repair (MTTR), such that the availability (as per IEEE standard P-1046 or equivalent) of the complete C&I system is to be assured at 99.7%. Availability information shall be submitted by bidder along with the bid.

When more than one device uses the same measurement or control signal the system shall be arranged so that the failure of any monitoring device shall not open the signal loop nor cause the loss or malfunction of signal to other devices using the signal.

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 devices shall be provided to ensure adequate safety of plant equipment.

Any modification required in primary measuring element up to first root valve for system design (in existing system) shall be provided by BPSCL.

It is mandatory to use sensors with 2 out of 3 logic for critical control & protection (Analog & Binary) application/service and sensors with 1 out of 2 logic for all other control & interlock (Analog & Binary) application/service.

4.2 OPERABILITY AND MAINTAINABILITY

Design

The design of the control system and related equipment shall be based on positive logic.

Obsolescence of Electronic Components and Parts

Bidder shall ensure supply of spare parts for life time of the plant. In case it is felt by Bidder 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.

Typical Redundancy Requirement of Measurements and Controls loops:

For critical control loops, triple redundant transmitters/ temperature elements shall be provided and shall be used in median selection for control purpose.

For other important measurements, 2 transmitters/ temperature elements shall be provided and one of the two shall be selected for control / display while the other shall be standby.

For critical protection systems, the measurements shall be 2 out of 3, i.e., 3 sensors / transmitters/switches used in a 2 out of 3 voting logic for protection function. Also, for the boiler MFT triple sensors/transmitter/switches shall be provided.

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5.0 C&I FOR MAIN PLANT EQUIPMENT

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C&I FOR MAIN PLANT EQUIPMENT

5.1 SG RELATED CONTROL & INSTRUMENTATION SYSTEM / EQUIPMENTS

BMS Scheme shall be based on the schemes furnished by SG Bidder and the implementation of schemes shall be subject to approval of Owner / consultant.

Boiler Control System

1. Fully proven PLC / DCS based system with hardware and software shall be provided to achieve the Boiler protection action e.g. master fuel trip (MFT), fuel equipment, BF/CO gas & fuel oil systems etc.

The control system shall be provided with automatic self-monitoring facility. All modules to be used in this system shall be of failsafe design. Any single fault in primary sensor, I/O modules, multifunction controllers, etc. should not result in loss of safety function. All faults should be annunciated for operator information and acknowledgement.

2. The MFT functions shall be implemented in a fault tolerant dual redundant configuration. Each of the two independent channels shall have its own dedicated redundant processors, redundant communication module, I/O modules, redundant interface, etc. All safety related process inputs shall be fed to each of the 2 channels. All the primary sensors for unit/boiler protection shall be triple redundant. Signal for each trip input shall be stamped with 1ms resolution for SER at the input level itself, without any processing so as to enable analysis in sequence of event, the exact cause of trip.
3. The acquisition and conditioning of binary and analog protection criteria signals for MFT shall be carried out in each of the two redundant channels. Each channel shall compute the 2 out of 3 logic and issue a trip command. The trip signals of the two channels shall be fed to a failsafe 2 out of 2 relay tripping unit for each drive. The protection criteria for tripping shall be executed by a program which shall be identical in each of the two redundant channels. The check back contact signals of each relay of the 2 out of 2 relay tripping unit shall be fed back to each of the redundant channels and shall be continuously monitored for equivalence in each of them.

In case one of the independent channels or any of the triple redundant sensors is faulty, the same shall be alarmed and the balance channels/sensors shall be operated in one out of the two modes.

4. The functionality of operation of fuel, oil etc. shall be similar to that of OLCS. The respective nozzle valves, isolation valves etc. required for oil firing, coal firing and gas firing, shall be operated through PLC / DCS in a planned sequence along with all interlock/protection
5. The BMS logic shall be designed to:
 - Prevent any fuel firing unless a satisfactory purge sequence has first been completed.
 - Prevent start-up of individual fuel firing equipment unless permissive interlocks have first been satisfied.
 - Monitor and control proper equipment sequencing during its start-up and shutdown.
 - Provide flame monitoring when fuel-firing equipment is in service and effect a burner trip or master fuel trip upon warranted firing conditions.
 - Continually monitor boiler conditions and actuate a master fuel trip (MFT) during adverse operating conditions which could be hazardous to equipment and personnel.
 - Reliably operates and minimize the number of false trips.
 - Provide a master fuel trip relay independent of processors and I/O modules to provide a completely independent trip path.

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- Provide all logic and safety interlocks in accordance with National Fire Protection Association (NFPA).
 - Include a first out feature in all controllers to identify the cause of any burner trip or boiler trip.
 - Provide a complete diagnostic system to immediately identify to the operator any system module failure.
 - Allow burners and igniters are to be started, stopped and tripped on a burner basis.
 - Allow the automatic start and stop of burners based on boiler load. The sequence of which burner will be started or stopped will be selected by the operator from OWS display.
6. All instruments required for the successful operation / control / protection of the systems within boundary limit and for existing system as per Annexure-2 shall be provided by Bidder. Annexure-2 is list of existing C&I system only which has to be supplied and installed by Bidder.

However, instruments for the new firing system and other mechanical process requirements as per scope of R&M shall be in Bidder's scope.

In overhauling scope, if any replacement is there, the erection and commissioning shall be done by Bidder and materials will be supplied by BPSCL.

7. Historical data storage shall be for minimum 30 days and after expiry, data shall be automatically/manually transferred to the external storage device such as DVD writer. Data is to be stored in Historical storage unit shall include alarms, event list, periodic plant data logs/reports such as startup logs, trip analysis logs, shift logs, daily logs etc.

MFT Parameters

Details of parameters for MFT shall be based on recommendation of SG Bidder and the implementation of MFT shall be subject to approval of Owner / consultant.

Spare Capabilities

Spares for I/O indicated below:

- Spare channels: 10% in each module evenly distributed.
- Spare modules: 25% of each type of module evenly distributed fully wired up to TB/marshaling panel.

The maximum permissible loading shall be as follows:

- Controller loading: 60%
- Data highway / communication link: 60%
- Historical storage: 70%
- Console: 70%

Operator cum Engineering Work Station

Engineer's equipment shall have operator station with 24" Color Graphic LCD (TFT) Monitor & printer to perform the functions of software generation and maintenance of control system. It shall also be used for monitoring the status of all equipment connected to control system.

Engineering Station should be able to carry out all the above functions in addition to configuration, database generation and Graphics editing.

Operator's Workstation (OWS)

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Each OWS shall consist of latest PC or Work Station with redundant communication link, one 24" and one 48" Color Graphic LCD (TFT) Monitor, Keyboard and mouse.

Printers, hard copiers etc. shall also be provided for generation of logs, reports and miscellaneous printouts.

Control and monitoring of plant through OWS shall be performed through different displays. Logs, summaries and reports shall be displayed and shall be printed on the printers.

a) Display unit

Various displays on the OWS shall include mimics representing plant process schematics, bar chart displays, X-Y & X-T plot (trend) displays, operator guidance message displays, group displays, plant start-up/shutdown message displays, system status displays etc. Number of displays and the exact functionality shall be on as required basis and as finalized during detailed engineering subject to the minimum quantities. For X-T & X-Y plots, the facility of providing a background grid on operator request shall be operator selectable with adequate no. of divisions in both co-ordinates.

b) Mimic Displays

These displays shall depict the process in graphical form and shall cover all the drives operable from control system and all process areas being monitored therein. There shall be two types of mimic display, broadly, i.e. Overview displays & sub-area/individual displays.

Facility of adding user specific symbols, dynamic symbols or animated graphics to the standard library shall be possible. It shall be possible to go to a predefined trend display on selecting a field on any analog point on the displays.

c) Pop-up Windows

It shall be possible to call this display as a Pop-up window from the controlled drives in main mimics.

Flame Monitoring (Scanner) System

The purpose of the system is to detect the individual flame and to enhance the boiler/furnace safety, to avoid spurious and unwarranted trips and to increase operational reliability, availability and efficiency of the Steam Generator such that the consumption of fuel oil shall be reduced to optimal minimum.

New multi fuel (oil, coal & BF/CO gas) type of scanners shall be provided which shall include flame detectors of proven design for the type of fuel, environmental condition and other conditions, of established reliability at all loads of the Steam Generator. It shall be designed to work under all adverse conditions such as wide variation in fuel/air input ratio, wide variation in fuel characteristics, variation in operating temperature, and maximum temperature under interruption of cooling air supply and shall be immune to Electro-Magnetic Interference (EMI). The system shall conform to NFPA recommendation and location of detectors as per NEC requirements. The Selection and location of the flame detectors/scanners shall be decided by the Bidder in consultation with OEM. The Bidder shall furnish the selection details of flame detector locations for Owners review.

Flame detector shall be working on the dynamic and static properties of primary combustion zone of each type of fuel and flicker frequency of flame. It shall pick up only the flame to which it is assigned and shall not respond to the adjacent and background flame or other radiation generated in the furnace. The design shall also take into account the absorption by a coal shroud, re-circulated dust or other deposition on the flame detector head. The complete system shall

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provide the discrimination between oil, coal & gas flame. Intensity indicators for main flame shall be provided along with galvanically isolated 4-20 mA DC signals and hooked to control system.

The system should be easily maintainable and include automatic self-test facility at regular interval.

The Bidder shall arrange flame detectors for coal flame, oil burner and BF/CO gas.

The Bidder shall demonstrate the complete performance of flame detectors in cold start up test and load condition test. It shall be ensured that the detectors are able to detect the proven flame at very low load with oil guns withdrawn. The above tests shall be performed for every coal, oil & BF/CO gas elevation.

5.2 HARDWIRED ALARM ANNUNCIATION SYSTEM

Alarm annunciation windows (as required) shall be provided by Bidder.

Microprocessor based Alarm annunciation system shall include all required logic sequence (for non PLC / DCS applications) and the panel mounted facia LED array assemblies, sets of alarm accept, reset, mute and test push buttons, panel mounted audible devices.

The system shall be immune to variations in the power supply and shall not generate spurious alarm when the system power is switched on (power-on-reset).

Hooters and Buzzers provided on the panel shall be electronic with adjustable volume and pitch control. Operator interface push button stations shall be provided in appropriate sets on panels as per functional groupings desired. Push button stations shall also be provided in Operator interface.

Annunciation system shall be designed to ensure during LED / System test, existing fault annunciation is automatically excluded from test program with latching of status at card level. Once test command is removed, the system should display once again the faults annunciations.

Input shall be provided with contact bounce filtering. The filter shall delay contact inputs for 15 milliseconds to protect against input device bounce and electrical noise on input lines. Size of Facia windows shall be 65 mm (W) X 35 mm (H), Contact shall be NO or NC configurable. Window Drivers shall be electronically short circuit protected, current limiting with automatic recovery.

Number of windows shall be determined during detailed engineering.

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6.0 MEASURING INSTRUMENTS

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MEASURING INSTRUMENTS

6.1 ELECTRONIC TRANSMITTER FOR PRESSURE, D.P., FLOW AND LEVEL

All the transmitters required for area within boundary limit and for existing system as per scope mentioned in Annexure-2 shall be provided.

Pressure Transmitter

- For all critical control applications, 3 transmitters shall be provided.
- The Drive protection trip due to pressure shall be derived from LVM of transmitter signal and not through switches.

Micro-processor based 2 wire, (loop powered) Smart type, indicating (LCD display), accuracy of $\pm 0.075\%$ of span, remote as well as manual zero and span adjustment. Turn down ratio 10:1 (for vacuum/very low pressure) & 30:1 for other application, Repeatability: $\pm 0.05\%$ of FSR or better. Self-diagnostics, temperature sensor for compensation. Powers supply 24 V DC; output signal of 4-20 mA DC. IP 65 or equivalent degree of protection. Aluminum housing with epoxy coating, AISI-316 SS sensing element or better. Process connection of $\frac{1}{2}$ inch NPT (F), Accessories like pulsation dampeners, 2 valve manifold for absolute pressure transmitters, 3-valve manifold for gauge/vacuum pressure transmitters, siphon, snubbers for pump discharge applications and chemical diaphragm with 15 m PVC covered SS armored capillary (each limb) for corrosive and oil services, nameplate etc. Material for accessories will be SS. HART protocol output shall be available in each transmitter.

Differential Pressure Transmitter

- For the measurements of Diff. pressure, flow, level
- For all critical control applications, 3 transmitters shall be provided.

Micro-processor based 2 wire, (loop powered) Smart type, indicating (LCD display), accuracy of $\pm 0.075\%$ of span, remote as well as manual zero and span adjustment. Turn down ratio 10:1 (for vacuum/very low pressure) & 30:1 for other application, Repeatability: $\pm 0.05\%$ of FSR or better. Self-diagnostics, temperature sensor for compensation. Powers supply 24 V DC; output signal of 4-20 mA DC. IP 65 or equivalent degree of protection. Aluminum housing with epoxy coating, AISI-316 SS sensing element or better. Process connection of $\frac{1}{2}$ inch NPT (F), Accessories like pulsation dampeners, 5 valve manifold for DP/level/flow transmitters, siphon, snubbers for pump discharge applications and chemical diaphragm with 15 m PVC covered SS armored capillary (each limb) for corrosive and oil services, nameplate etc. Material for accessories will be SS. HART protocol output shall be available in each transmitter.

Level Transmitter

DP transmitters (smart type) can be used for level measurement. The transmitter shall provide suitable 4-20mA dc output signal for control and indication/recording.

Ultrasonic Level Transmitter

Microprocessor Controlled, Reflected ultrasonic Operation pulse, Measuring Ranges shall be min. 30 meters or as process requirement. Operating Frequency shall be from 10 KHz to 50 KHz. Calibration & Configurable from front of the panel, Power supply of 240 V AC 50 Hz / 24V DC, Output contacts of 2SPDT Signal Output of 4-20 mA DC (isolated) - 600 Ohm load. Hysteresis shall be fully adjustable, On-line Diagnosis. Accuracy & Repeatability shall be of 0.25% of span or better, Resolution of 0.1% of span. 50 deg. C Operating temperature shall be for Transmitter and 80 deg. C shall be for Sensor or as per process requirement. MOC of Sensor Body shall be PVC

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and Face Polyurethane. IP-65 Epoxy painted die cast aluminum or Polycarbonate housing, Cable Connection of 3/4" ET, Mounting of 2" for sensor and Transmitter on panel, Status of for power, level indication of Hi / Lo / V. Hi / V. Lo-, fault etc., Display shall be of Large alpha-numeric back lit LCD/LED, Construction of plug-on board, Accessories like Cable gland, prefab cable, mounting accessories.

6.2 TEMPERATURE MEASUREMENT

Temperature Indicators

Temperature indicators shall be provided for following applications:

- On all process lines where local indication is warranted by the system either for monitoring or testing.
- Capillary type temperature indicators shall be used in vibration prone areas.
- Thermowell shall be provided for all temperature indicators.

Thermowells

All thermowells shall be provided along with new temp gauge, thermocouples & RTDs. Old thermowells which are related to BMS/MFT logics shall be replaced.

Pipe/equipment mounted temperature / test wells of 316 SS with a process connection of M33 x 2 threads or 150 RF flanged. Accessories like name plate, plugging with chain, etc. shall be provided. Material of accessories will be SS. Thermowell shall be hex head of bar stock assembly. In case flanged wells are required for any specific application, the same shall be supplied as required. The thermowell construction shall meet the ANSI 19.3-1994 (latest) requirements.

The thermowell shall be hard faced/ satellite to avoid erosion for boiler area applications.

Thermocouple

All existing thermocouples related to BMS/MFT/Auto control logics system shall be replaced with new ones. Additional new temperature measurement TC shall be provided as required.

Thermocouples shall be Duplex type with accuracy of $\pm 0.5\%$ of span, spring loaded mineral insulated, housed in aluminum casing (epoxy coated), IP 65 or equivalent degree of protection for enclosure. Thermocouple assembly shall be complete with 316 SS thermowell, having a process connection of M33 x 2 thread or 150 RF flanged. Thermowell with hex head (with screwed cover & SS chain) bar stock assembly with ungrounded junction. Temperature devices provided with thermowells shall be calibrated with the associated thermowell as an assembly. For metal temperature measurement, thermocouple pads weldable to M.S pipes shall be provided with 15 m flexible thermocouple extension wires. Element size shall be 18 AWG. Insulation resistance at 540oC shall not be less than 5 M ohms.

Thermocouple types shall be

- 'K' type sheathed, mineral insulated, 6 mm thickness as per ANSI-MC96-1 with ungrounded hot junction.
- Thermowells: The thermocouples and RTDs are to supplied with suitable thermowells wherever required
 - Oil, Feed water, steam, Metal temp measurements: SS316
 - Flue gas and pulverized coal path: Inconel coated with 1 mm thick Tungsten carbide.

Resistance Temperature Detectors (RTD)

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All existing RTD's related to area under boundary limit shall be replaced with new ones. Additional new temperature measurement RTD shall be provided as required.

RTDs shall be Duplex PT-100 type with accuracy of $\pm 0.5\%$ of span, spring loaded mineral insulated three (3) wire RTD assembly housed in aluminum casing (epoxy coated), IP 65 or equivalent degree of protection for enclosure. RTD shall be supplied as an assembly complete with thermowells meeting ANSI 19.3-1994 (latest) requirements. Thermowell shall be 316 SS having a process connection of M33 x 2 thread or 150 RF flanged. Thermowell with hex head with screwed cover & SS chain, bar stock assembly. Element lead size will be 18 AWG. The insulation resistance at 540oC shall not be less than 5M ohms. Repeatability over full range shall be better than 0.02%. RTDs shall be ungrounded. Material of accessories (name plate, etc.) will be SS.

METAL TEMPERATURE MEASUREMENT

Boiler Tube Metal temperature measurement shall be mineral insulated (MI) thermocouples with MgO filled metal sheathed extension wires terminated in junction boxes at boiler platforms.

6.3 PR. GAUGE, D.P. GAUGE, LEVEL GAUGE

All Gauges required for systems under boundary limits shall be replaced/provided.

Pressure Indicator/Gauges

Pressure indicators shall be provided for

- Suction and discharge lines of pumps, including on header section, if two or more pumps are employed for the same service.
- Suction and discharge lines of fans, including on header section if 2 or more fans are employed for the same service.
- All input and output lines of process equipments.

Direct reading, pipe mounted Pressure gauges of SS casing with 4 1/2 inch phenolic dial white dial with black numerals (for skid mounted applications), for all other 6 inch phenolic dial (white dial with black numerals), 316 SS Bourdon tube, AISI 304 movements and micrometer type adjustable aluminum pointer, an accuracy of $\pm 0.5\%$ of span including accessories like siphons for steam services, snubbers for pump discharge applications and chemical diaphragm with 15M PVC covered SS armored capillary for corrosive and oil services and name plate, etc. Material of accessories will be SS. IP65 or equivalent degree of protection for enclosure. Over range protection will be 50% above maximum pressure.

Differential Pressure Indicators

Direct reading type, pipe / rack mounted, bellows or diaphragm operated differential pressure indicators; aluminum casing (epoxy coated) with six (6) inch dial (white dial with black numerals), with micrometer type pointer, 316 SS pressure element; an accuracy of $\pm 0.5\%$ of span including accessories like snubbers for pump discharge application, chemical diaphragm with 15 m PVC covered SS armored capillary for each limb for corrosive and oil services and 5 way manifold & name plate, mounting brackets, etc. Material of accessories will be SS. IP 65 or equivalent degree of protection. Over range protection will be 50% above maximum pressure.

Level gauges

Level gauge glasses shall be provided on all tanks and the maximum length of one gauge glass shall not exceed 1 meter. The gauge glasses shall be stacked to cover the complete height of the tanks including over flow level. There shall be an overlap of minimum 150 mm, when more than

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one level gauge is required. Suitable platforms shall be provided for purpose of taking measurements and during maintenance.

Tubular type level gauges for low-pressure up to 7 kg/cm² & reflex type for high-pressure water & steam services & vacuum services with automatic ball check valves, illuminator (240 AC) Pyrex/ borosilicate glass, mica shield, brass guard rods & brass holders. Material of accessories (name plate, etc.) will be SS. Tubular glass OD will be 5/8". Vent & drain valves shall be provided. Connection shall be screwed or flanged (ANSI class 150 RF).

6.4 FLOW ELEMENTS

Primary and Secondary air flow measurement shall be provided.

Bidder shall submit certified flow calculation, Sizing calculation and differential pressure vs. flow curves as well as fabrication and assembly drawings and installation drawings for each element for Owner's approval.

6.5 DIGITAL INDICATORS

Miniaturized digital indicators, if provided for the indication of important process and electrical parameters etc. shall meet the following general specifications.

1.	Input signal	4-20 mA
2.	Size	48 mm (w) x 24 mm (h)/50 mm x 25 mm
3.	Display Accuracy	2.5% of final value
	Temp. coefficient	0.15% /°C of measured value
4.	Mounting	Flush panel
5.	Type	3½ digit seven segment LED display. Float decimal.

6.6 FUEL FLOW MEASUREMENT

Coriolis type Fuel oil flow measurement to be provided as required.

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7.0 UPS / DC POWER SUPPLY SYSTEM

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UPS AND DC POWER SUPPLY

A standalone on-line 2 × 100% parallel redundant UPS with common battery bank of suitable rating for existing C&I equipments of Boiler # 01, along with Bidder supplied Control & Instrumentation system, shall be provided.

The 24 V DC power supply for powering field contact and modules shall be provided through redundant AC/DC power converters of suitable rating.

Bidder shall consider 24 V DC supply to be derived from UPS (230V AC) by using the suitable redundant convertor as per system requirement.

Battery sizing and location, distribution boards, length and size of cables should be decided by the Bidder.

The Bidder shall be fully responsible for engineering and furnishing a complete and operational system fully meeting the intent and requirements of this specification. All equipment and accessories required for completeness of this system shall be furnished by the Bidder whether these are specifically mentioned herein or not. All the equipments and sub systems offered shall be from reputed experienced manufacturers. All system cabinets, enclosures, & distribution boards shall be manufactured, assembled, wired and fully tested as a complete assembly at the manufacturer's works before dispatch.

AC power to PLC / DCS shall be supplied through a redundant UPS.

Bidder shall clearly bring out in the proposal the redundancy features along with necessary single line diagram; data sheets etc.

All required voltage level to make the system complete with redundant supply along with battery and charger are under bidder's scope.

Uninterruptible Power Supply (UPS) System

The UPS system shall have 2x100% parallel redundant chargers and inverters, 1x100% battery bank, bypass line transformers and voltage stabilizer, static switch, manual bypass switch, AC/DC distribution boards, other necessary protective devices and accessories and shall meet the following requirements as a minimum.

The KVA rating of UPS shall be as required by expected loads and include 10% spare capacity at 50 deg. C ambient. If UPS KVA rating is applicable at a lower ambient temperature than specified 50 deg. C, the Bidder shall consider a derating factor of at least 1.5%/deg. C for arriving at the specified UPS capacity at 50 deg. C ambient. The UPS shall have an over load capacity of 125 % rated capacity for 10 minutes and 150 % rated capacity for 10 seconds. The inverter shall have sufficient capability to clear fault in the maximum rated branch circuit. The sizing of UPS shall be based on the power factor of the loads being fed subject to a maximum of 0.8.

Each of the two sets of 2x100% redundant chargers shall be sized to meet the 100% UPS load plus recharge the fully discharged battery within 8 hours. Other applicable features as specified under 'Float cum Boost Chargers" above shall also be provided. However, charger efficiency shall be 90% minimum.

The UPS battery shall have sufficient amp-hour capacity to supply 100% full load current of UPS for 60 minutes. For this, the UPS capacity shall be considered as the finally selected UPS rating, irrespective of the actual load on UPS. A drop of 4V from battery room to the inverter input will be

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considered for design. Battery should be sealed maintenance free Plante type Lead Acid batteries with long life.

The UPS system shall be capable of operating without D.C. battery in circuit under all conditions of load and the performance of various components of UPS like inverter, charger, static switch etc. shall be operable without the battery in circuit.

The UPS system design shall ensure that in case of failure of mains input power supply to one of the chargers, the other charger whose mains input power supply is healthy, shall feed to one or both the inverters as the case may be as per manufacturer's standard practice & continue to charge the D.C. battery at all load conditions. The Bidder should note that this situation should not in any way lead to the discharge of the D.C. Battery.

Static Inverters

The static inverter shall be solid-state type using proven Pulse Width Modulation (PWM)/Quasi-square wave/step wave technique. The inverter equipment shall include all necessary circuitry and devices to conform to requirements like voltage regulation, current limiting, wave shaping, transient recovery, automatic synchronization etc. The steady state voltage regulation shall be +/- 2% and transient voltage regulation (on application/removal of 100% load) shall be +/-20%. Time to recover from transient to normal voltage shall not be more than 50 mSec. Frequency regulation for all conditions of input supplies, loads and temperature occurring simultaneously or in any combination shall be better than $\pm 0.5\%$ (automatically controlled). The total harmonic content shall be 5% maximum and content of any single harmonic shall be 3% maximum. The inverter efficiency shall be at least 85% on full load and 80% on 50% load. The synchronization limit for maintenance of synchronization between the inverter and stand by AC source shall be 48-52Hz, field adjustable in steps of 0.5 Hz.

Over Load, Short Circuit and Load Loss

The inverter shall be provided with suitable HRC fuses at the inputs and outputs which will permit proper coordination with other protective devices and at the same time protect the inverter against damage due to internal faults. However, if the Bidder's system design does not use fuses then the fuse free circuit breaker may also be permitted provided it meets the specification requirement. All necessary equipment shall be provided to protect the inverter against overload, short circuit and 100% loss of load. The inverter shall be self-protecting against damage if energized with full load connected.

Inverter equipment shall include all solid-state circuitry and devices including stable oscillator etc. to enable inverters to operate satisfactorily in parallel sharing mode each inverter taking 50% load during normal operation. In case of failure of either inverter, 100% load shall automatically be transferred to healthy inverter without any break and degradation in the quality of UPS output and disconnecting the faulty inverter automatically.

The inverter failure shall be alarmed and the healthy inverter shall get synchronizing signal from the standby AC source and remain synchronized within the set limits. The limits for the synchronization between healthy inverter and standby AC source shall be field adjustable.

On failure of both inverters, the loads shall be transferred to standby AC power without a break if within synchronization limits. However, such transfer shall be inhibited, during operation of inverter on its internal oscillator, to the standby AC and standby AC source shall be field adjustable.

On failure of both inverters, the loads shall be transferred to standby AC power without a break if within synchronization limits. However, such transfer shall be inhibited, during operation of

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inverter on its internal oscillator, the to standby AC source frequency being beyond the synchronization limits. Provision of asynchronous transfer with a break in case of inverter being out of synchronization limits shall also be there with standby source.

Static Switch and Manual Bypass Switch

The static switch shall be provided to perform the function of transferring UPS loads automatically without any break from (i) faulty inverter to standby AC source in case of failure of both the inverters and (ii) from faulty inverter to standby AC source in case of failure of both the inverters.

Manual bypass switch shall be employed for isolating the UPS during maintenance.

Step Down Transformer and Voltage Stabilizer

The transformer shall be of low impedance type and the rating shall be such that extremely fast fault clearance is achieved, even in the largest rated branch circuit.

The overload capacity of the transformer/stabilizer shall not be less than 300% for 200 msec. The stabilizer shall employ silicon solid state circuitry and the output voltage regulation shall be $\pm 2\%$. The efficiency of the stabilizer shall be 95% or better.

AC Distribution Board (ACDB)

The details of the AC distribution board, i.e. exact design, number of feeders etc. of the 2x100% ACDB shall be as finalized during detailed engineering and as approved by Purchaser. However, 25% spare feeders (min. 1 nos.) with fuses for each rating shall be provided.

i) Site Tests

The Bidder shall also carry out the site tests on equipments/systems as specified below. However, these shall not be limited to this specification only and in case any other site test is required to be conducted as a standard practice of the Bidder or deemed necessary by the Owner and mutually agreed between the Bidder and the Owner, the same shall also be carried out.

Functional Test

On completion of installation and commissioning of the equipment the following tests/checks shall be carried out with the maximum available load, not exceeding the rated continuous load.

Light Load Test

This test is carried out to verify that the UPS is correctly connected and all functions operate properly. The load applied is limited to some percent of rated value. The following points should be checked:

Output voltage and frequency and the correct operation of meters;

- Operation of all control switches and other means to put units into operation.
- Functioning of protective and warning devices.
- Operation of remote signaling and remote control devices.

Checking of Auxiliary Devices

The functioning of auxiliary devices, such as lighting, cooling, pumps, fans, annunciation, etc., should be checked, if convenient, in conjunction with the preliminary light load test.

Synchronization Test

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If possible, frequency variation limits should be tested by use of a variable frequency generator, otherwise, by simulation of control circuit conditions.

AC Input Failure Test

The test is performed with a fully charged battery and is carried out by tripping input circuit breakers or may be simulated by switching off all UPS rectifiers and bypass feeder at the same time. Output voltage variations are to be checked for specified limits with an oscilloscope or equivalent. Frequency variation is defined as the steady state frequency of the UPS with and without AC input. The rate of change of frequency is measured by the time it takes to reach steady-state values.

AC Input Return Test

AC input return test is performed by closing AC input circuit breakers, or is simulated by energizing rectifiers and bypass feeders.

Proper operation of rectifier starting and voltage and frequency variations are to be observed.

Transfer Test

This test is applicable for UPS with bypass, particularly in the case of an electronic bypass switch. Transients shall be measured during load transfer to bypass caused by a simulated fault and load retransfer after clearing of the fault.

Full load test

Load tests are performed by connecting the actual load to the UPS output.

Load tests are necessary for testing output voltage and frequency, rated stored energy, recharge time, ventilation, temperature rise and determination of efficiency. Load tests are performed to prove transient voltage deviations specified under step load conditions.

UPS Efficiency

UPS efficiency should be determined by the measurement of the active power input and output.

Actual Load Test

Conditions under actual load may differ from those with a dummy load. Steady-state generation of current and voltage harmonics and transients at load switching conditions should be observed.

Current Division in Parallel UPS

Load sharing between the UPS units shall be measured with actual load under conditions of parallel operation.

Rated Stored Energy Time (Battery Test)

This test is a load test to prove the actual possible time of battery operation.

If rated load is not available in the case of large UPS, it is possible to apply a partial load to check the actual battery discharge characteristics and compare these with characteristics specified by the battery manufacturer. Discharge time with rated load shall then be calculated. The test shall be performed with a fully charged battery. Active power output of the UPS and the battery voltage shall be recorded during the test.

Since new batteries often do not provide full capacity during a starting up period, the discharge test may be repeated after a reasonable recharge time if the original test has failed.

Rated Restored Energy Time

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Restored energy depends on the charging capacity of the rectifiers and the battery characteristics. If a certain recharging rate is specified, it shall be provided by repeating the discharge test after the specified charging period.

On site Ventilation Test

The test is performed with the actual load. Temperature conditions of all UPS cubicles are to be observed.

Overload Capability Test

Overload capability test is a load test. Specified values of short time overload or starting up sequences of actual load are to be applied for the time interval specified. Specified values of voltage and current are to be recorded.

Short Circuit Fuse Test

Fuse tripping capability of a UPS shall be tested, by short-circuiting the UPS output via a fuse of specified type.

The test shall be repeated to ensure against fuse non-uniformity and switching time during the cycle. The test is carried out at an appropriate UPS load under normal operation.

Restart

Automatic or other restart means are to be tested after a completed shutdown of UPS.

Output Over voltage

Output over voltage protection is to be checked.

Periodic output voltage modulation.

When this test is specified, it may be checked by voltage recording at different loads and operating conditions.

Harmonic Components

Harmonic components of output voltage shall be checked with the actual load.

Methods of specification and checking shall be subject to Purchaser's approval.

Earth Fault Test

If the UPS output is isolated from earth, then an earth fault can be applied to any output terminal. UPS output transients (if any) shall be measured.

If the battery is isolated from earth, then an earth fault can be applied to any output terminals. UPS output transient (if any) shall be measured.

Type Tests

Type and routine test certificates for components used in the UPS system shall be furnished. Tests for components shall be as per relevant standards. Tests on the following equipment shall be as per the relevant standards.

7.1 GROUNDING AND EARTHING SYSTEM

Grounding

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

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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).

Screen on instrumentation cables shall be grounded at panel / cabinet end. Suitable terminals shall be furnished on copper flat forming system ground. System / shield ground shall be connected to earthing strip.

Earthing System

If the system furnished by Bidder requires its own isolated earthing, the same shall be provided by Bidder.

A separate instrumentation earth pit shall be provided for the I&C system (PLC / DCS & control system/ equipment / instruments) by bidder which shall be isolated from the plant earth.

Shields of the instrumentation cables shall be terminated on earth bus in each cabinet. This earth bus shall in turn be connected to the instrumentation earth pit.

7.2 AUXILIARY EQUIPMENTS

All required auxiliary equipment/materials as finalized during detailed engineering shall be furnished with each rectifier bank, UPS & battery bank and shall include as a minimum various meters (AC/DC voltage/current, kVA, power factor, frequency meters etc.), circuit breakers, selector switches, push buttons indicating lights, ground detector system, battery accessories like (inter cell connectors, inter step connectors, teak-wood battery racks etc.) isolated 4-20 mA signals for important parameters and potential free contacts for important alarms shall be provided for use in control system.

Following accessories and devices required for maintenance and testing of batteries shall be supplied for each set of the batteries:

a.	Hydrometer	2 Nos.
b.	Set of hydrometer syringes suitable for the vent holes in different cells	2 Nos.
c.	Thermometer for measuring electrolyte temperature	2 Nos.
d.	Specific gravity correction chart	2 Nos.
e.	Wall mounting type holder (of teak wood) for hydrometer & thermometer	2 Nos.
f.	Cell testing voltmeter (3-0-3 V)	3 Nos.
g.	Alkali mixing jar	2 Nos.
h.	Rubber aprons	5 Nos.
i.	Pair of rubber gloves	5 Nos.
j.	Set of spanners	5 Nos.
k.	No smoking notice for each battery room	2 Nos.
l.	Goggles (industrial)	2 Nos.
m.	Instruction card	5 Nos.
n.	Temperature indicator	1 No. / room
o.	Cell lifting facility	1 Set / room
p.	Discharge resistance	1 Set / room
q.	Suitable capacity Exhaust fans	As required

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7.3 BATTERY RACKS

Two tier battery racks of MS construction in accordance with applicable codes and standard shall be provided.

7.4 DRAWINGS/DOCUMENTS REQUIREMENTS

Bidder shall furnish the power supply distribution scheme, single line diagram, all calculations for Rectifier Modules / UPS Charger / Inverter rating/sizing & battery sizing etc. for DC system as well as for UPS during detailed engineering for Owner's review and approval.

7.5 LOAD END POWER SUPPLY DISTRIBUTION

Bidder shall provide power supply distribution panels/cabinets/ boxes for sub-distribution of main UPS/ DC/ Utility feeder(s) on as required basis. These shall include necessary auto-change over circuitry, switch-fuse units, MCB, terminal blocks etc. suitable for the application. The design of these distribution panels/cabinets/boxes shall be as approved by Owner during detailed engineering stage. Each of the control cabinets, however, shall be provided with redundant DC/UPS feeders.

7.6 CABINETS / ENCLOSURES

The Construction details for Power supply System Cabinets/ Enclosure/Racks shall conform to the requirements of the following paragraphs.

1. Equipment enclosures shall match and line up in assemblies of freestanding floor mounted cabinets designed for indoor service.
2. Individual enclosure shall be ventilated switchboard type fabricated from not less than 1.6-mm thick sheet steel. Enclosures shall be furnished with concealed hinges. Front and rear doors shall be designed to permit easy access to all components for maintenance or replacement. The enclosures shall be reinforced with formed steel members as required to form a rigid self-supporting structure. Doors shall have three point latches.
3. Each assembly may be shipped in sections for ease of handling and field assembly. Terminal blocks shall be furnished as required adjacent to each shipping split to facilitate field assembly. Cable bundles cut to the required length and furnished with terminal lugs tagged for identification shall be provided for the wiring between shipping sections.
4. Adequate ventilating louvers and enclosure top panels shall be included. All vent openings shall be covered with corrosion resistant fine screen coverings.
5. The temperature rise inside all the cabinets/enclosures shall not exceed 10 °C above ambient temperature. Bidder shall furnish calculation to establish this during detailed engineering stage.
6. The Color shade of Panels exterior/interior shall be RAL 7032 or as decided during detail engineering.

7.7 COOLING SYSTEM

If the equipment supplied requires forced air cooling, the cooling system furnished shall meet the following requirements:

1. Reserve cooling equipment shall be furnished for each assembly. Reserve fan capacity shall be equal to 100 percent of cooling fan requirements for full load operation with only one bank of rectifier/inverter in service at the specified maximum ambient temperature.

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2. Completely independent duplicable wiring and control systems shall be provided for the normal cooling fan system and the reserve cooling fan system.
3. Each cooling fan shall normally run continuously and shall be powered from the output of the inverter whose enclosure it serves (for cubicles housing inverters). For other cubicles, fan power supply shall be as finalized during detailed engineering. Each cooling fan supply circuit shall be separately fused.
4. Each cooling fan shall be equipped with an airflow switch having an alarm contact that closes upon failure of airflow.

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8.0 IMPULSE PIPING & ERECTION HARDWARE

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8.1 IMPULSE PIPING

Bidder shall get all the necessary drawings, layouts, hook-up diagrams and documents for the existing impulse piping from owner. In case of non-availability of the drawings, layouts and , hook-up diagrams the bidder to visit the site for the feasibility, condition, connections, hook-up diagrams etc. of various pressure rating as required by Bidder to complete the job awarded to him is under bidders scope.

Actual estimate of Impulse Piping shall be done by bidder. Same shall be supplied by bidder. Also, Old Impulse Piping is to be removed and it is in the bidder's scope.

All materials supplied under this Sub-section shall be suitable for intended service, process, operating conditions and type of instruments used. The material offered by the Bidder shall be from reputed, experienced manufacturer with proven experience in pulverized coal fired stations.

Impulse Piping, Tubing, Fittings, Valves and Valve Manifolds

Impulse pipe downstream of root valves shall be under scope of supply and erection by Bidder.

All impulse pipes required for the burner firing controls and other areas within boundary limits and for existing system as per ANNEXURE-2, instrument isolation, drain valves and all fittings/couplings etc. downstream of root valves shall also be included in scope of Bidder.

Suitable access platforms are required for some locations in order to reach the instruments for routine maintenance.

All impulse pipes 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.

Stainless steel tube shall be provided inside enclosures & racks from tee connection to valve manifold and then to instrument. For high pressure/temperature applications (piping classes A, B, C &D of the table no. PCP) the material shall be ASTM A 213 TP 316H and for other applications material shall be ASTM A 213 TP 316L. The wall thickness of the tube shall be in accordance with the ANSI B31.1 standard.

Size and thickness of piping/tubing shall be suitable for the design pressure and temperature conditions as per ANSI 16.11.

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 ASTM A 182 Gr. 316 H for high pressure/ temperature applications and ASTM A 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.

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 shall 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.

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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.

For Pr. /D.P gauges in fluid application two-way globe valve on each impulse line to the instrument and in Air & Flue gas application two-way gate valve on each impulse line to the instrument shall be provided near the instrument. These shall be in addition to the three ways gauge cock provided along with the PR /D.P gauges.

Impulse piping material shall be the same as the parent pipe material. Impulse piping of SS316 shall be provided for all sampling lines up to the analyzer. For transmitters, SS 316 piping / tubing shall be used within the transmitter rack for connecting from the manifold up to the transmitter. At transmitter rack input, bulkhead fittings shall be provided to be suitable for connecting impulse pipe at outside end, and impulse tube at the inside end. Length of impulse piping from tapping point to rack shall be generally limited to 10 meters.

For impulse pipes / tubes and fittings, IBR certificate shall be provided as applicable. Bidder shall provide thermal insulation for sampling pipes for the purpose of personnel protection so that the temp. outside the insulation is not more than 60oc. Insulation shall be lightly bonded mineral wool. Tubing shall be complete with union connections and end fittings at supply and receiving ends. All fittings with SS tubing shall be stainless steel double compression type fittings.

Impulse pipe / tube fittings & accessories

Nipple shall be provided for root valve size more than ½ inch and the nipple size shall be same as the root valve size. Reducer/adaptor shall be provided to suit instrument connection, where nipple, root valve size is more than ½ inch.

Fittings

All fittings except the last fitting connecting to the instrument (or to bulkhead fitting for transmitter racks) shall be socket welded. The size of the fittings shall be same as the impulse line size. The fitting connecting to the instrument shall have a size and thread to suit the instrument connection.

Drain

Drain shall be provided for all water/steam and non-inflammable/non- corrosive fluids only.

Drain valve

Two numbers of globe drain valves shall be for process conditions of 300oc or 40 bar and higher. One number globe drain valve shall be provided for process conditions of less than 300oc and 40 bars. The valve size shall be same as impulse piping/tubing size. For air/flue gas measurement a drain pot with plug shall be provided in place of drain valves.

Gunmetal valves are not allowed for any instrumentation applications.

All instrumentation Isolation valve should have drain facility.

Funnel with drain header

This shall be provided in the racks for blowing/draining out the process fluid in the impulse tubing's. The size of the drain header shall be 1". When instruments are mounted local to the tapping point and are not mounted in the rack, or panel or enclosure, the drains shall be connected to the nearest floor level or plant drain.

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Air Supply Piping

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.

This will include as a minimum air supply to pneumatically operated control valves, actuators, instruments, continuous and intermittent purging requirements etc.

For individual supply line and control signal line to control valve, 1/4-inch size seamless SS tubes with double compression SS tube fittings shall be used. Alternatively, 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 brass, screwed type with ferrules for sealing.

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.

For air supply to various devices mentioned above, the Bidder shall provide 2-inch size GI pipe header with isolation valve from the instrument air and service air terminal points. In the boiler area the 2-inch header shall be provided up to top most elevation of boiler floor and from this 2-inch header, 1-inch sub-header shall be branched off at each floor with isolation valve. From this 1 inch sub-header, branch line of 1/2 inch, with isolation valve shall be provided up to various devices.

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.mm max. Inlet pressure. The filter shall be of size 5 microns and sintered bronze material. The air set shall have 2-inch size pressure gauge and built in filter housing blow down valve.

All the isolation valves in the air supply line shall be gate valves of SS as per ASTM 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 1/2 inch to 2 inch.

Purge Air Connection for Air and Flue gas Applications

This shall be provided for flue gas pressure measurements. Instrument air connection shall be provided at each instrument for flue gas service for purging.

One air filter regulator, purge Rotameter and a blow down device per instrument rack shall be provided on the common purge air supply line.

The purge line shall be connected to each instrument through a 1/2" isolating valve.

Purging arrangement is not required for Instrument air and service air measurement applications.

Purge airlines shall be of mild steel hot dipped galvanized inside and outside as per IS1239, heavy duty with threaded ends.

Instrument Piping System

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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. 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 along with isolation valves and other accessories including drainpipes. This drain is to be connected to plant drain through open funnel also.

All impulse piping shall be installed to permit free movement due to thermal expansion. Wherever required expansion loops shall be provided.

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 in water services above 120 Deg. C. For drum level measurement balancing chamber shall be provided.

Color coding of all impulse pipes shall be done by the Bidder in line with the color coding being followed for the parent pipes.

Instrument Air & Service Air Piping/ Tubing System

Air piping shall be installed always with a slope of over 1/20 to prevent accumulation of water within the pipe.

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.

Piping/Tubing Support

All Boiler side Instrument Air piping is in bad shape and shall be replaced completely.

Impulse piping and sample piping shall be supported at an interval not exceeding 1.5 meters. Each pipe shall be supported individually using mounted clamps with necessary fixtures. Tubing shall run in proper perforated trays with proper cover. Tubing shall be supported inside the trays by aluminum 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 other fastening hardware shall be of corrosion resistant metals and hot-dip galvanized.

Shop and Site Tests

General Requirements

The equipment and work performed as per this Sub-section shall be subject to shop and site test as per Purchaser approved quality assurance plan.

Hydrostatic and pneumatic tests shall be performed on all pipes, tubing and systems and shall conform to ANSI B31.1.

Hydrostatic Testing

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.

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Air Testing

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.

Pressure and Differential Pressure Transmitter Racks

Open type transmitter racks with canopy to mount all pressure, differential pressure and flow transmitters with vibration dampener; air supply lines and header will be provided with bulk head fittings to receive impulse lines; Also provided with blow down/drain header. The material of accessories will be SS. Drains shall be connected up to suitable drain header.

Transmitter rack with continuous purging arrangement shall be provided in boiler area flue gas system. Air filter regulator and purge Rotameter shall be provided.

8.2 PROCESS CONNECTION AND IMPULSE PIPING

Table PCP

System/Line Description	Piping Class	Impulse Pipe Material	Schedule (Size)	Materials for Fitting/ Valve Body	Valve Stem Material	Rating of Piping/ Fittings	Pr. Class of Valve
Main Steam	A	ASTM-A335 Gr.P-22	XXS (1/2 inch)	ASTM-A182 Gr-F-22	ASTM-A-182 Gr.F-6a	9000 lb	3000 SPL
BFP discharge/ superheater attemperator	B	ASTM-A106 Gr. C	160 (1/2 inch)	ASTM-A105	ASTM-A-182 Gr.F-6a	6000 lb	2500
	C	ASTM-A106 Gr. C	160 (1/2 inch)	ASTM-A105	ASTM-A-182 Gr.F-6a	6000 lb	1500
Air/ Flue gas outside furnace	M	ASTM-A106 Gr. B/C	80 (3/4 inch)	ASTM-A105	ASTM-A-182 Gr.F-6a	3000 lb	800
Air/ Flue gas inside furnace	N	ASTM-A335 Gr. P22	80 (3/4 inch)	ASTM-A182 Gr. F-22	ASTM-A-182 Gr.F-6a	3000 lb	800
Note:							
1	Rating of piping/fittings/valves etc. is subjected to the final design pressure & temperature during the detailed engineering.						
2	In case temperature is more than 540 °C, the material shall be P-91 only.						
3	Material shall be compatible with that of the impulse pipe material and design parameter.						

Actual estimate of Impulse Piping shall be done by the bidder and the same shall be supplied and erected by bidder. Also, Old Impulse Piping is to be removed and it is in bidder's scope.

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9.0 CABLES & ACCESSORIES

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9.1 INSTRUMENTATION CABLES

Bidder shall get all the necessary drawings, layouts, cable schedule and documents for the existing cables and its cabling system from site. In case of non-availability of the drawings, layouts and various schedules the bidder to visit the site for the feasibility, condition, connections, wiring & termination details etc. of various cabling system as required by Bidder to complete the job awarded to him is under bidder's scope.

Actual estimate of Control & instrument cable shall be done by bidder. Same shall be supplied by bidder. Also, Old Control & instrument cable are to be removed and it is in the bidder's scope.

Preparations of cable schedule & inter connection diagrams are under bidder scope.

Extension cables shall be supplied as required.

All required instrument & control cable to be supplied, lay & terminated by bidder's (irrespective of any one end or both ends in their scope).

General

Generally the following cable types shall be used.

- Overall and pair shielded armored cables for Analog Signals & overall Shielded armored cables for Digital Signals
- Overall and triad shielded armored triad cables for RTD signals

All cables shall be laid as per the design and functional requirements and connected to control system to ensure overall functioning of the plant.

All the power cables required for UPS and power distribution system are in the scope of Bidder.

The Bidder shall supply, erect, terminate and test all instrumentation cables for control and instrumentation equipment/devices/systems included under Bidder's scope ensuring completeness of the control system.

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

Bidder 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.

Instrumentation Cable Specifications

All the instrumentation cables i.e. twisted and shielded multipair cables, compensating/extension cables, pre-fabricated cables etc. shall be flame retardant low smoke (FRLS) type. The Cables shall be provided in non-returnable drums. The drum length shall be 1000m (+/-5%) up to & including 8 pairs and 500 m (+/- 5%) above 8 pairs.

Voltage grade of the instrumentation cables shall be 225 V (peak value).

All instrumentation cables covered in this specification shall comply with VDE 0815, VDE 0207, Part 4, Part 5, Part 6, VDE 0816, VDE 0472, SEN 4241475, ANSI MC 96.1, IS-8784, IS-10810 (latest editions).

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The conductor shall be of minimum 0.5-sq.mm sizes, high conductivity, and multi-stranded copper for all types of instrumentation cables.

The insulation of individual conductor shall be extruded PVC meeting the requirements of VDE 0207 Part 4 compound Y I3. The outer sheath of instrumentation cables shall be extruded PVC (compound YM1) as per VDE 0207 Part 5 and shall be of flame-retardant low smoke (FRLS) type. The cable shall be provided with marking including manufacturer's name, insulation material, and conductor sizes, no of pairs, voltage ratings, type of cable etc. Progressive sequential marking of the length of the cable at every one meter & progressive markings to read 'FRLS' at every 5 meters shall be provided on the outer sheath of all instrumentation cables. Color coding & color banding shall identify pairs of Cables. The color of outer sheath shall be sky blue so that C&I cable is easily distinguished from other cables.

Fillers in multiple conductor cables shall be flame retardant and moisture resistant. Cable accessories such as harnessing components, markers, bedding, cable jointer, binding tape etc. shall also have flame retardant quality.

Core identification, color coding shall be as per VDE 0815.

All instrumentation cables shall be provided with overall shielding. However multipair cables carrying analog signals shall be provided with individual pair shielding in addition to overall shielding. Shielding shall be of Aluminum-Mylar tape with 100% coverage and with at least 20% overlapping. The thickness of individual pair shield shall be 28 micron (minimum) and that of overall shield shall be 55 microns (minimum). Separate drain wires for individual pair shield (wherever applicable) as well as overall shield shall be provided. Drain wire shall be of seven (7) strand 20 AWG (0.51 Sq.mm) tin coated copper conductor. Maximum lay of individual twisted pair shall be 50 mm. Insulation thickness of individual core shall be between 0.28 and 0.35 mm for 0.5 mm² cables. The outer sheath of the instrumentation cables shall meet the following minimum requirements:

- An Oxygen index of not less than 29% and a Temperature index of not less than 250 deg. C as per ASTM-D-2863.
- Maximum acid gas generation by weight as per IEC-754-I shall not be more than 20%.
- Smoke Density Rating shall not be more than 60% during Smoke Density Test as per ASTM-D-2843. The results of smoke density test shall be plotted on a curve indicating light absorption vs. time as per ASTM-D-2843. The average area under the curve (smoke density rating) shall not be more than 60%.
- Complete cable assembly shall pass Swedish Chimney test as per SEN-4241475 and flammability test as per IEEE-383.

The thickness of outer sheath shall be as per the guidelines given in VDE 0816. Thickness of outer sheath shall not be less than 1.8 mm in any case. The variation in diameter and the ovality at any cross section shall not be more than 1.0 mm.

All instrumentation cables shall be suitable for continuous operation at 70 deg. C, except for high temperature resistant Teflon insulated cables, which shall be suitable for continuous operation at 205 deg. C. The cables shall be suitable for laying in wet or dry locations in trays, conduits, ducts, and trenches and underground buried installations.

9.2 THERMOCOUPLE EXTENSION CABLE

Extension cables shall be supplied as required.

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Actual estimate of Extension cables shall be done by bidder and same shall be supplied by bidder.

The thermocouple extension cables shall be of single/multi pair 600V twisted pair (20 twist/meter), 1.5 mm² dia. They shall be PVC insulated, aluminum Mylar tape shielded/PVC jacketed/ armored& overall PVC jacketed/FRLS. They shall be compatible for the type of thermocouples used. Features such as color coding, thermo electric characteristics etc. shall be as per ANSI STD-MC.96-1, 1975.

All cables near high temperature zone like burner front devices, boiler metal temperature thermocouples, thermo-couples on main steam etc. shall be high temp cables, which shall be terminated at a junction box in normal temperature zone. Thermocouple extension cables and copper conductor cables for high temperature applications shall be with insulation of individual conductor and outer sheath of extruded FEP (i.e., Teflon) as per VDE 0207 Part 6 and ASTM D 2116. The thickness of outer sheath shall be 0.5 mm nominal (i.e., 0.4 mm minimum). Insulation thickness of individual core shall be between 0.28 and 0.35 mm. These cables shall be single/multipair, twisted & shielded.

Cable parameters such as mutual capacitance between conductors, conductor resistance, insulation resistance, characteristic impedance, cross talk and attenuation figures at 20 deg. C (\pm 3 deg. C) for various types of cables as applicable shall be furnished.

Identification of the cores & pairs shall be done with suitable color coding & band marking as well as by numbering of cores/pairs as per VDE: 0815. The details of color coding etc. shall be as approved by Purchaser during detailed stage.

The Bidder shall furnish all documentary evidence including test certificates to substantiate the suitability of cables offered for different applications. The Bidder shall also clearly bring out the application wise details for each type of cable offered.

All prefabricated cables shall have 10% spare cores, which will not be connected to pin connectors.

9.3 INSTRUMENTATION CABLE TERMINATION / INTERCONNECTION PHILOSOPHY

The cable interconnection philosophy to be adopted shall be such that extensive grouping of signals by large scale use of field mounted Group JB's at strategic locations (where large concentration of signals are available, e.g. switchgear) is done and consequently cable with higher number of pairs are extensively used. JB's to be furnished under this specification shall be of 12/24/36/48/64/72/96/128 way. The material, dimension and interior/ exterior color of JB's shall be subject to Purchaser's approval.

Terminal Blocks

All terminal blocks shall be rail mounted/post mounted, cage clamp type/other standard 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, instrument enclosures/racks, etc., shall be suitable for cage clamp connections. The terminal blocks for CONTROL SYSTEM 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.

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

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and test plug (as specified above for SWGR connections) transparent covers, support brackets, distance sleeves, warning label, marking, etc.

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/marshaling 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.

For ensuring proper connections, Bidder shall provide suitable accessories, along with insulation sleeves.

Internal wiring in factory pre-wired electronic equipment cabinets might be installed according to the Bidder's standard as to wire size and method of termination or internal equipment.

TBs with fuse should be provided for all input signals to CONTROL SYSTEM panels.

Terminals shall have following features:

600 V grade, vertically mounted, size of 0.5 sq mm to 1.5 sq mm for instrument wires and 1.5 sq mm to 2.5 sq mm for control wires. Clearance between TBs will be 150 mm and between TB and bottom plate will be 250 mm. TBs shall be flame resistant, non-hygroscopic and de-carbonized. Insulation between adjacent terminals or between terminals & frame work and will be 2 kV RMS for 1 minute, Power supply and signal TB shall be separate. Signals shall be grouped in TBs in the same order as that in junction box so as to provide neat cable layout and wiring. High voltage and low voltage signals shall be provided on separate TBs.

Instrumentation & Control Cables and Prefabricated Cables Termination Guidelines

- To connect field instruments to field junction boxes/Local Panels. For switches, both the SPDT contacts of switches shall be wired up to the J.B.
- To connect limit switches, torque switches and position transmitters to their respective field junction boxes.
- Extension cable shall be supplied for connection between the element and the respective junction boxes / system cabinets as per guidelines.
- Prefabricated cable for connecting between system cabinets, marshaling cabinet to system cabinet, system cabinet to Relay Rack, etc.
- Cabling between interposing relay cabinet to the marshaling cabinet located in MCC room.
- Cabling between Junction boxes and marshaling cabinets.

Note: Heat Resistant Instrumentation cable (PTFE) with armoring shall be used hot zone area.

Wiring, Termination and Accessories

Instrument Wires

Wires shall carry 4-20 mA DC or any other low voltage or current signals. Used for panel internal wiring, tinned copper conductor of 0.5 sq mm cross-section with seven strand and twisted pair with 20 twists/meter. Insulation material shall be PVC; heat resistant FRLS with thickness not more than 0.5 mm and voltage grade will be 1100V.

Control Wires

Wires used for power supply like 110V AC, 240V AC, 220V DC and $\pm 24V$ etc. Used for panel internal wiring, tinned copper conductor of 1.5 sq mm cross-sections with minimum seven strands. Insulation material shall be PVC, heat resistant with FRLS properties, voltage grade will be 1100V.

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9.4 PREFABRICATED CABLE

Used for interconnection between systems /marshaling cabinets. Used for panel external wiring, tinned copper.

Conductor of 0.5 sq mm cross-section with seven strands twisted pair with 20 twists/meter. Insulation material shall be PVC, heat resistant with FRLS properties with thickness not more than 0.5mm. Voltage grade will be 1100V.

Each prefabricated cable shall have a minimum of 5 cores as spares and these should not be connected to end connectors.

9.5 PANELS/CABINETS INTERNAL WIRING

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.

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.

All internal wires shall be provided with tag and identification nos. etched on tightly fitted ferrules at both ends. All wires directly connected to trip devices shall be distinguished by one additional red color ferrule.

Maximum of 2 wires shall be terminated per terminal. Wiring raceways, straps shall be flame retardant. All wiring shall be ferruled. Wires carrying power and signal wires shall be routed in separate raceways. Accessories like MCB, cable support fuses, etc. shall be supplied. Cable entries shall be cemented with fireproof compound.

All external connection shall be made with one wire per termination point. Wires shall not be tapped or spliced between terminal points.

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.

All the special tools as may be required for solderless connections shall be provided by Bidder.

Wire sizes to be utilized for internal wiring:

- Current (4-20 mA), low voltage signals (48V) - 0.5 Sq.mm.
- Ammeter/voltmeter circuit, control switches etc. for electrical system. - 1.5 Sq.mm.
- Power supply and internal illumination - 2.5Sq.mm.

9.6 CABLE INSTALLATION AND ROUTING

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 Purchaser.

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 415V tray system - 610 mm

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- From control cable tray system - 305 mm

Cables shall terminate in the enclosure through cable glands. All cable glands shall be properly gasketed in the gland plates. Fireproof sealing to prevent dust entry and propagation of fire shall be provided for all gland plates used for cable entry.

The cables emanating from redundant equipment/devices shall be laid through different routes.

Cable Laying and Accessories

- Cables shall be laid strictly in line with cable schedule.
- Identification tags for cables: 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.
- Cable tray numbering and marking: To be provided at every 10m and at each end of cableway & branch connection.
- Joints for less than 250 Meters run of cable shall not be permitted.
- Buried cable protection: With concrete slabs; Route markers at every 20 Meters along the route & at every bend.
- Road Crossings: Cables to pass through buried high density PE pipes encased in PCC. At least 300 mm clearance shall be provided between LT power & LT control/instrumentation cables
- Segregation: In order to ensure physical isolation to prevent fire jumping, 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.
- 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.

9.7 JUNCTION BOX (JB)

Junction boxes to be supplied by bidder's as on required basis. Also, old Junction boxes (as required) are to be removed and it is in the bidder's scope.

Junction Boxes shall have following features:

- Double door type with cable entry from bottom.
- 12/24/36/48/64/72/96/128 way with 20% spare terminals.
- Spring-loaded terminals shall be used.
- 4mm thick fiberglass reinforced polyester.
- Door shall be screwed at all four corners. Door handle shall be self-locking with common key. Door gasket shall be of synthetic rubber.
- 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.
- Terminals shall be rail mounted cage-clamp type suitable for conductor size upto 2.5 mm². An M6 earthing stud shall be provided.
- Enclosure shall be IP: 55 or better for indoor locations. For all outdoor (Boiler area) locations the protection class shall be IP 65.

Conduits

All rigid conduits, couplings and elbows shall be hot dipped galvanized rigid mild steel in accordance with IS: 9357 Part-I (1980) and Part-II (1981). The conduit interior and exterior surfaces shall have continuous zinc coating with an overcoat of transparent enamel lacquer or zinc chromate. Flexible conduit shall be heat resistant lead coated steel, water, fire and rust proof. The temperature rating of flexible conduit shall be suitable for actual application.

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XLPE, FRLS Cables - Instrumentation Cables, Control & Power Cable & Cables Sub-Trays

All instrumentation cables, Control & Power cables as applicable for interconnection of all equipment/system/devices in Bidders scope as well as for connection of signals from/to systems like MCC/LT SWGR/HT SWGR (even if they are not in Bidder's Scope.) etc. along with necessary laying & termination accessories, hardware etc. shall be under Bidder's scope. All sub trays along with supporting, connecting hardware etc. required for lying of instrumentation, control, power and other cables etc. for instruments supplied by Bidder, up to main cable trays are under Bidder's scope.

9.8 OPTICAL FIBRE CABLES

Optic Fiber cable shall be 4/8/12 core, corrugated steel taped armored, fully water-blocked with dielectric central member for outdoor/indoor application so as to prevent any physical damage. The cable shall have multimode / multiple single-mode fibers as required by the communication system so as to avoid the usage of any repeaters. The core and cladding diameter shall be 50+/- 3 and 125+/-2 micrometer for multimode fibers and 9 +/- 1 micrometer and 125 +/- 1 micrometers for single mode fibers respectively. The wavelength, Bandwidth & Attenuation for multimode fibers shall be 1300nm, 500 MHz*KM & 0.8 dB/Km respectively. Attenuation for single mode fibers at 1300nm wavelength shall be 0.4dB/Km. Multiple single-mode fibers shall be used for distance more than 1 km. The outer sheath shall be Flame Retardant, UV resistant properties and identified with the manufacturer's name on it.

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. 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. The operating temperature shall be -20 deg. C to 70 deg. C.

All testing of the fiber optic cable being supplied shall be as per the relevant IEC-793-2, EIA-568A, IS11801 and other international standards.

Bidder to ensure that minimum 100% cores are kept as spares in all types of optical fiber cables.

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10.0 CONTROL VALVES, ACTUATORS & ACCESSORIES

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10.1 CONTROL VALVES, DAMPERS, ACTUATORS

All necessary Control valves and modulating dampers of OBMS and GBMS shall be supplied along with pneumatic actuators. Air and flue gas dampers are not required. Only electrical actuators are required for them as specified in Annexure II. Make shall be subject to Owner's/consultant approval.

General Requirements

All final Control elements (Control valves & control dampers) shall be with pneumatic or electric actuators with provision of manual operation. All actuators would be sized so that the final control elements operate properly even when the upstream pressure exceeds 110% of maximum value.

Multistage/Single stage, anti-cavitations, balanced/unbalanced, modulating, globe type, cage guided /top guided as per the process requirements, single ported, diaphragm type of actuator with hand wheel, Pneumatic / electronic positioner, air filter regulator, air lock device, solenoid valve, limit switches and position transmitters. Fail freeze I/P converters shall be suitable for accepting 4-20 mA DC signal. Pneumatic (SS) tubing complete with accessories, fittings, and positioners shall be provided with input/output/bypass gauges. Local position indicator & non-contact type position transmitter with 2 wires, 4-20mA DC output. All limit switches/position transmitters, I/P converter signals etc., shall be wired out to external block of actuator and respective junction boxes.

Either extended type bonnet or cooling fin type bonnet shall be provided for service above 200°C and for other service the bonnet type shall be standard.

Water seal shall be provided for valves that could be subjected to below atmospheric conditions.

Generally stem and guide material (trim) shall be SS 316 satellite, and plug and seat material will be 17-4 PH SS, except for specific applications like DM water. The noise abatement shall be obtained by valve body and trim design and not by use of silencer. The trims supplied shall be suitable for quick changing. Actuator housing shall be of pressed steel construction.

The control valve design shall be suitable for the required fail-safe conditions, of process/equipment. The valves shall be supplied and commissioned as per the fail-safe philosophy required for the process. Wherever the required turndown is not possible with a standard single valve, specially designed trims shall be customized and used.

Pneumatic actuators would be provided with air failure lock and remote release, limit switches, adjustable minimum and maximum stops, load position indicators, positioners, non-contact type electronic position transmitters and solenoid valves in accordance with the system requirements. The control valves and accessories equipment furnished by the Bidder shall be designed, constructed and tested in accordance with the latest applicable requirements of code for pressure piping ANSI B 31.1, the ASME Boiler & pressure vessel code, Indian Boiler Regulation (IBR), ISA, as well as in accordance with all applicable requirements of the "Federal Occupational Safety and Health Standards, USA" or acceptable equal standards. All the Control Valves, their actuators and accessories to be furnished under this Sub-section will be fully suitable and compatible with the modulating loops covered under the Specification.

All the control valves and accessories offered by the Bidder shall be from reputed experienced manufacturers of specified type and range of valves.

Control Valve Sizing & Construction

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The design of all valve bodies shall meet the specification requirements and shall conform to the requirements of ANSI (USA) for dimensions, material thickness and material specification for their respective pressure classes.

The valve sizing shall be suitable for obtaining maximum flow conditions with valve opening at approximately 80% of total valve stem travel and minimum flow conditions with valve stem travel not less than 10% of total valve stem travel. All the valves shall be capable of handling at least 120% of the required maximum flow. Further, the valve stem travel range from minimum flow condition to maximum flow condition shall not be less than 50% of the total valve stem travel. The sizing shall be in accordance with the latest edition of ISA handbook on control valves. While deciding the size of valves, Bidder shall ensure that valves trim exit outlet velocity as defined in ISA handbook does not exceed 8 m/sec for liquid services, 150 m/sec. for steam services and 50% of sonic velocity for flashing services. Bidder shall furnish the sizing calculations clearly indicating the outlet velocity achieved with the valve size selected by him as well as noise calculations.

Control valves for steam and water applications shall be designed to prevent cavitations, wire drawing, flashing on the downstream side of valve and downstream piping. Thus for cavitations/flashing service, only valve with anti cavitations trim shall be provided. Control Valve sizing calculations shall be furnished.

Control valves for application such as SH Spray Control, Heavy Oil Heating, pressurizing and Control system shall have permissible leakage rate as per leakage Class V. All other control valves shall have leakage rate as per leakage Class-IV. Leakage class for double-seated valve shall not exceed 0.05%, and single seated valve shall not exceed 0.01%.

The control valve induced noise shall be limited to 85 dBA at 1 meter from the valve surface under actual operating conditions. The noise abatement shall be achieved by valve body and trim design and not by use of silencers.

Valve Construction

All valves shall be of globe body design & straightaway pattern with single or double port, unless otherwise specified or recommended by the manufacturer to be of angle body type. Rotary valve may alternatively be offered when pressure and pressure drops permit.

Valves with high lift cage-guided plugs & quick-change trims shall be supplied.

Cast Iron valves are not acceptable.

Bonnet joints for all control valves shall be of the flanged and bolted type or other construction acceptable to the Owner. Bonnet joints of the internal threaded or union type will not be acceptable.

Plug shall be of one-piece construction cast, forged or machined from solid bar stock. Plug shall be screwed and pinned to valve stems or shall be integral with the valve stems.

All valves connected to vacuum on downstream side shall be provided with packing suitable for vacuum applications.

Valve characteristic shall match with the process characteristics.

Extension bonnets shall be provided when the maximum temperature of flowing fluid is greater than 280 deg. C.

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Flanged valves shall be rated at no less than ANSI press class of 300 lbs.

10.2 VALVE ACTUATORS

The Control valves shall be furnished with electrical actuators. The Bidder shall be responsible for proper selection and sizing of valve actuators in accordance with the pressure drop, maximum shut off pressure and leakage class requirements. The valve actuators shall be capable of operating at 60 deg. C continuously.

Valve actuators and stems shall be adequate to handle the unbalanced forces occurring under the specified flow conditions or the maximum differential pressure specified. An adequate allowance shall be provided for stem force, at least 0.15 Kg/sq.cm. per linear millimeter of seating surface in the selection of the actuator to ensure tight seating unless otherwise specified. The travel time of the electrical actuators shall not be less than 40 seconds.

10.3 CONTROL VALVE ACCESSORY DEVICES

All pneumatically actuated control valves and dampers of OBMS and GBMS shall have accessories such as air locks, hand wheels, limit switches, Smart type microprocessor based smart electronic positioners, E/P Converters, diffusers, external volume chambers, position transmitters (capacitance or resistance type only), tubing and air sets, solenoid valves shall be provided as per the requirements.

The microprocessor based smart electronic positioners shall have the following features: It shall accept 4-20 mA signal from the control system as input and provide a compatible signal for driving the pneumatic actuator.

In addition to electrical to pneumatic signal conversion & positioning functions, it shall also perform detailed diagnostics & make available the actuator/control valve faults via a HART interface. The HART signal for the detailed faults shall be superimposed on the 4-20 mA control signal itself. The faults to be covered shall include valve jamming, air supply failure, leakage etc.

The Positioner shall have provision of 4-20mA position feedback output to the control system.

Positioner shall have facility of characterization of the valve (i.e. equal percentage, quick opening, linear, etc.).

The Positioner shall have facility of detection of control signal failure & making the valve either stay put/open/close as per process requirement upon this condition.

In Vibration prone areas, positioners shall be located away from the control valve/damper.

Electric to Pneumatic (I/P) Converters

I/P converters and associated accessories shall be furnished in accordance with the specifications given below:

Air supply

Input signal: 4-20mA DC (as required by the design of control system), Output signal: 0.2 to 1.0 kg/cm sq., Linearity: 0.5% of span or better, Hysteresis: 0.1% of span or better, Ambient temp. Effect: less than 0.02% of span per °C between -20 to +60 °C. Mounting: Close to actuator (but not on the actuator), output capacity to suit the actuator, protection class IP-55, along with o/p signal Pressure gauge (0-1.6 Kg/cm², 21/2 "dial).

On loss of control signal, the last set point pressure shall be maintained so that the associated control valve remains in stay put position without using any solenoid valve. The allowable drift

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rate will be $\pm 2\%$ of set point/hour maximum. This feature is not required for fuel oil flow/pressure control valve at Boiler front

10.4 TEST AND EXAMINATION

All valves shall be tested in accordance with the quality assurance programme which shall meet the requirements of IBR and other applicable codes mentioned elsewhere in the specifications. QAP shall be approved by the Owner / consultant. The tests shall include but not be limited to the following:

- Non-Destructive Test as per ANSI B-16.34.
- Hydrostatic shell test in accordance with ANSI B 16.34 prior to seat leakage test.
- Valve closure test and seat leakage test in accordance with ANSI-B 16.34 and as per the leakage class indicated above.
- Functional Test: The fully assembled valves including actuators control devices and accessories shall be functionally tested to demonstrate times from open to close position.
- CV Test: CV test shall be carried out as type test on each size, type and design of the valves as per ISA 75.02 standard and test report shall be furnished for Owner's approval.

10.5 ELECTRIC ACTUATORS WITH INTEGRAL STARTERS

Type

The actuators shall have integral starters along with over load relays with built in SPP (Single Phasing Preventer). A 415, 3 phase 3 wire power supply shall be given to the actuator from Bidder's/Purchaser's switchboard as applicable through a switch fuse unit. Control voltage of the motor starter shall be 110 V AC / 24 V DC, derived suitably from 415V power supply.

In case supplier's standard control voltage for Open/Close contactors is 110V AC, the same is acceptable if suitable Opto Isolation circuit is provided with coupling relays for 24 V DC command inputs.

Interfaces

Open/Close command termination logic with position & torque Limit Switches, positioner's circuit shall be suitably built in the PCB inside the actuator.

For Binary Drive: - Open/Close command & status thereof and disturbance monitoring signal (common contact for Overload, Thermostat, control supply failure, L/R selector switch at local & other protections operated) shall be provided.

Interface with the control system shall be through hardwired signal only. Inter posing relays provided (with coil burden 2.5 VA) in the actuator shall be energized to initiate opening and closing, by 24V DC signal from the external control system.

For Modulating Drive: - the command to actuator shall be in the form of 4-20mA signals. The necessary positioning circuit and motor protection shall be provided.

Open/close command termination logic shall be suitably built inside actuator.

Duty requirement shall be:

For Open/Close at rated speed against designed differential pressure at 90% of rated voltage.

For isolating service: - three successive open-close operations or 15 min, whichever is higher.
For regulating service 150 starts per hour or required cycles, whichever is higher.

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Construction

- a) Enclosure:
It shall be totally enclosed weather proof minimum IP-55 degree of protection.
- b) Gear Train:
Metal (Fiber gears are not acceptable) self-locking to prevent drift under torque switch (where ever applicable) spring pressure when motor is de-energized.
- c) Manual Wheel:
It shall disengage automatically during motor operation.

Motor

- Type: Squirrel cage induction motor. Direct on line starting with starting current limited to six times the rated current.
- Supply Voltage & frequency: 415V +/- 10%, 3 Phase, 3 Wire 50HZ +/- 5%.
- Enclosure: Totally enclosed, self-ventilated IP-55 degree of protection.
- Insulation: Class B or better. Temperature rise 70 °C. over 50 °C ambient
- Bearings: Double shielded, grease lubricated antifriction.
- Earth Terminals: Two
- Protection: Single Phasing Protection, over heating protection through Thermostat and wrong phase sequence protection shall be provided over and above other protection features standard to Bidder's design Suitable means shall be provided to diagnose the type of fault locally.

Position/Torque Switches

Four nos. (2 each in open and close position) position limit switches and two nos. (One in open and other in close direction) torque switches each having two nos. NO and two nos. NC contacts shall be provided. A single shaft shall actuate all contacts of limit switches at each position.

Local Operation

It shall be possible to operate the actuator locally also. Lockable Local/Remote Selection Shall Be Provided On The Actuator.

Position Indicator

To be provided for 0 to 100% travel.

Position Transmitter (For Modulating/Inching Type)

As required. Suitable for stabilized 4-20 mA signal, 2 wire inductive type, 24 volts DC operated.

Terminal Box

9 pin plug and socket (1 no. per actuator to suit 4 pair 0.5 sq.mm. Copper overall shielded (16 mm OD), instrumentation cable) suitably mounted in the starter box itself to terminate open/close command and status feedback signals with external control systems.

Additional one number 9 pin plug and socket (to suit 4 pair 0.5 sq.mm copper (16 mm OD) individual and overall shielded instrumentation cable) suitably mounted in the starter box itself for actuators with 4-20 mA position transmitters.

Necessary glands for power cables shall be provided.

Space Heater

Space heater shall be of suitable rating. The supply shall be derived from the main power supply available in the actuator.

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10.6 CONTROL DAMPER DRIVES

Pneumatic actuator type, located in OBMS and GBMS area with damper shaft bearings mounted externally. Bearings are grease lubricated. Blades (SS) shall be linked together. Accessories like position transmitters (2 wires) with 4-20mA DC output. Position indicator, position locks, limit/torque switches, etc. shall be supplied. Positioners with all required accessories, required for the positioning of control damper drives shall be provided. Spare cams for accommodating any change in characteristic to achieve better process control during commissioning shall be supplied as required.

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11.0 CONTROL ROOM, PANEL, DESK & CABINETS

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11.1 CONTROL ROOM LAYOUT

This Central control room located on the operating floor is in the Turbine building.

Operator work station and peripherals shall be located in the Control room. The system cabinets, marshaling cabinets and electrical auxiliary cabinets shall be located in the electronic cubicle room.

The control room shall accommodate the following equipment like:

- Operator Work Stations
- Operator cum engineering work station
- Printer
- Any other equipment necessary

Location of UPS shall be decided during detail engineering.

All Items referred above shall be mounted in an air-conditioned environment. The bidder shall submit a control room layout drawing clearly indicating the dimensions of the control panels / desks, system cabinets, marshaling cabinets, OWS, Printers etc. to be supplied replacing the existing panels. Doors, knockout doors, floor opening required for cable entry, etc shall also be indicated.

11.2 CONTROL DESK, PANELS, CABINETS ETC.

All control desk system cabinets, local panels etc. shall be furnished fully wired with necessary provision for power receptacles, internal lighting, grounding, ventilation, space heating, anti-vibration pads & accessories as per IS: 5039-1969 as required for completeness of the system.

All panels/desks/cabinets shall be freestanding type & have bottom entry for cables unless otherwise specified. The bottom of desk panel/cabinet/enclosures shall be sealed with bottom plate, compression cable glands and fire proof sealing material to prevent ingress of dust and propagation of fire.

All electronic system cabinets shall be designed for operation under 50 deg. C. without air conditioning system in service. Further cabinets/panels shall be so designed that temp. rise due to heat load does not exceed 10 deg. C above ambient temp. Under all operating conditions. Necessary louvers/ fans, limited packing density, adequate spacing between instruments/ devices etc. shall be provided to maintain temperature rise within permissible limits.

Desk /Cabinets wiring shall be arranged to enable the removal of instruments/devices without unduly disturbing them.

All desk / cabinets interiors shall be illuminated with rapid start fluorescent strip fixtures with door-actuated switches. Door switch terminals shall be shrouded. All illumination lights shall be provided with individual switch in parallel with door switch.

Sufficient number of power receptacles with disconnect switches shall be installed within panels/desk.

All desk/cabinets shall be properly grounded. The grounding scheme shall be furnished by the Bidder for owner's approval.

Exterior steel surface shall be sand blasted, ground smooth, filled, primed, sanded and smooth enamel painted to give a good finish subject of minimum paint thickness of 65-75 microns for

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sheet thickness of 3 mm and 50 microns for sheet thickness of 2mm. Minimum 2 coats of primer and two sprays of final finish color shall be applied to all surfaces.

The color of the desk / cabinets shall be brilliant white in the panel interior. External color of the panels will be as RAL 7032 or as decided during detailed engineering for local control panel, cabinated, panels, LIE/ LIR and other CER & offsite mounted system cabinets, etc.

The unit control desk and the control room design shall conform to the DIN 33414 (Ergonomic design of control room), Part-2 for cognitive factors and Part-4 for arrangement principles.

Miscellaneous Cabinets / Panels

- Smoke detectors shall be provided inside the CER mounted system cabinets.
- The cabinets/ panels shall be provided with eye bolts for lifting.
- Feeder failure/ healthy indication shall be provided in each cabinet & remote indication shall be hooked up to CONTROL SYSTEM/ annunciation & suitably grouped.
- All panels/ cabinets/marshaling cabinets shall be provided with a minimum of 20% spare terminations. The spare space capacity shall be distributed evenly throughout the cabinets.

11.3 FURNITURE

The Bidder shall provide necessary industrial grade furniture (desks, tables, chairs etc) for monitors, peripherals and operators/engineers in the control room etc.

Chairs

Industry standard wheel chairs with provision for adjustment of height shall be provided for the operator & unit in charge & other personnel in control room area. These shall be designed for sitting for long duration and shall not cause undue stress.

Tables

- a) Industry standard computer tables shall be provided & shall be as approved by Purchaser.
- b) Conference Room standard tables shall be provided with acrylic coat for good finish.

The Bidder shall design, supply the furniture to meet the intent of the specification and indicate the basis of design, bill of quantities in the offer.

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12.0 ERECTION, TESTING AND COMMISSIONING

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C&I Erection, Field Testing and Commissioning Requirements

The Bidder shall calibrate all the field instruments after establishing a standard instrument Lab at site and erect, test and commission all Instrumentation and Control Equipment supplied, under this bid to the complete satisfaction of the Owner/Engineer.

Erection Requirements

- a) The actual location of transmitter racks, local instrument rack/enclose, junction boxes and other instruments shall be decided by the Bidder depending on the site conditions considering the layout and maintenance aspects.
- b) The Bidder shall get prior approval as per approved quality assurance plan of the Owner / Consultant before any installation work starts. If any work is carried out by the Bidder before prior approval from Owner / Consultant and modification is sought by Owner / Consultant later, then the work will be redone by Bidder without any cost/ material implications to the Owner / Consultant.
- c) Impulse / sample piping, air supply and pneumatic tubing, cable trays and equipment shall be supported rigid enough to prevent vibration and anchored sufficiently to prevent strains on equipment installed. Supporting clamps shall be provided at least at every one meter distance for better rigidity. Impulse / sampling piping shall be provided with adequate slope, (preferably 1:10). Hangers and supports shall be so installed as not to interfere with free expansion and contraction of the piping and tubing between anchors. Suitable vibration dampeners, etc., shall be provided wherever necessary. In addition, care should be taken that the arrangement of impulse / sampling piping, air supply and pneumatic tubing are safe from detrimental sagging, mechanical injury. All impulse lines joints shall be welded type unless otherwise specified.
- d) All the panels, desk, cabinets supplied by the Bidder shall be bolted to the floor channel.
- e) All impulse lines from outlet of root valve and up to Instrument inlet port including all isolating and drain valves are in Bidder's scope.
- f) Control & instrumentation cables from Switchgear / MCC / Electrical Breakers to PLC / DCS / control system shall be laid by Bidder and terminated at both end by him.
- g) Control & instrumentation cables for SOV/MOD/MOV/field instruments/LIE/LIR/JB etc. shall be laid by Bidder and terminated at both ends by him.

Testing Requirements

- a) The Bidder shall set up his own instrument laboratory. The calibration equipment shall cover complete range and shall have the desired accuracy of not less than 0.1%. All the calibration equipment shall have the certification from National Physical Laboratory (NPL) or 'IDEMI' for the duration of Contract Period.
- b) The Bidder shall follow the standard procedures for calibration of various instruments and as set by the manufacturer of instruments and as instructed by the Owner including any requirements of field calibration. First, the calibrations shall be carried out independently by the Bidder and later in the presence of Owner who shall certify the same. Proper documentation in this regard shall be maintained and handed over to the Owner.
- c) All the instruments shall be calibrated for the entire range of the instrument for which it is designed. Calibration shall include test for repeatability. After first commissioning, the

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instruments shall be tested for calibration again to check whether the instrument maintains its zero and maximum of the range.

- d) All instruments and control equipment shall be calibrated to read correctly to the satisfaction of equipment supplier / Owner.
- e) All switches shall be tested for the actuation of both normally open and normally closed contacts at the desired set points and also for the fixed / differential settings.
- f) All the float operated level switches shall be tested for the movement of the float and linkages to make to break the switch contacts by filling up with water before installation. For such tests, necessary testing set up required shall be arranged by the Bidder. All the conductivity type probes and switches shall be tested for performance before installation.
- g) Air leak tests shall be performed on all flue gas impulse / sample lines, air supply and pneumatic lines. Necessary equipment such as portable compressor, connecting pipes, materials, cables and test gauges shall be provided by the Bidder.
- h) Hydro test shall be performed for all other impulse lines / sampling lines. Necessary equipment such as hydro test pumps and temporary piping to the required point, fill pump etc., materials such as temporary gaskets, miscellaneous fasteners, etc. tools and tackles including test pressure gauges, etc. are to be provided by the Bidder.
- i) For all electrical actuators of the valves, functioning, setting and performance of limit switches / torque switches of various positions shall be checked before and after installation of the actuators. The position transmitters for inching applications shall also be calibrated.
- j) Pneumatic actuators shall be calibrated at site.

Commissioning Requirements

- a) Prior to taking the instruments in service, all impulse lines, sampling lines and air supply lines shall be blown as required with the establishment of adequate line pressure and temperature conditions to keep the lines thoroughly clean.
- b) On-line i.e., without removing control valves from the pipe calibration of the positioners and stroking of control valves / control dampers shall be carried out as required during control system tuning.
- c) After delivery of the equipment, the Bidder shall locate all the equipment including electronic cards in its final position, check all the power wiring, grounding and interconnection cables, all in accordance with manufacturer's recommendations. The Bidder shall perform initialization of system power, field loading of system configuration / software and data base, demonstration of system functionality to verify conformance with manufacturer's instructions and specifications, tuning of control loops, implementation of any configuration changes including hardware, software and additional tapings / instruments, cabinets as required and providing general trouble shooting and final solutions to application and / or instrument problems.

Erection, Field Testing and Commissioning of complete functional C&I system including new PLC / DCS based system, integration of existing control system with PLC / DCS, field instruments, etc., shall be done by the Bidder.

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13.0 SYSTEM COMPLIANCE REQUIREMENT OF C&I SYSTEM

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Measurement System (MS)

Accuracy of each instrument shall be as specified in relevant Section of this volume.

Interlock, Protection and Sequential Control System

The Bidder shall demonstrate the proper functioning of interlock, protection and sequential control system as specified in relevant Section of this volume.

Data Bus System (DBS)

The Bidder shall demonstrate that the data bus system shall not be overloaded (above 60%) even under peak data transfer load. The response time as specified in relevant Section of this specification shall also be demonstrated.

Operator Interface Equipment

The Bidder shall demonstrate the proper functioning of Control Engineer's interface equipment as specified in relevant Section of this volume.

Auxiliary Power Supply System

The Bidder shall demonstrate the proper functioning of auxiliary power supply (UPS) system as specified in relevant Section of this volume.

Software Packages

The Bidder shall demonstrate the proper implementation and functioning of all Software packages.

Local Instruments/Panel Mounted Hardware

All indicators and switches like pressure switches, level switches, control switches, selector switches, relays etc. shall be demonstrate for proper functioning within an accuracy called for.

Flame monitoring system

The Bidder shall demonstrate the proper functioning of Flame scanner as specified in relevant Section of this volume of the specification..

Total System Availability

The Bidder shall demonstrate the total system availability of 99.7% and it shall be substantiated with Calculations and shall be demonstrated prior to taking over of the system.

Performance

The Bidder shall demonstrate that the goods furnished by him shall be in full accordance with the requirements of the specifications.

Quality

The Bidder shall warrant that the goods are new and of high quality and that the goods will be free of defects in design, materials or workmanship. Bidder shall warranty the same for a period of twelve (12) months from the date of taking over of the plant.

Performance Testing

The performance figures and formula for calculating availability of the system shall be furnished by Bidder and mutually agreed procedure shall be ready before the commencement of the PG test.

The tests shall be performed on the system during the PG test.

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Redundancy shall be checked for processor, communication, power supply and I/O modules. This check shall be conducted in a sequence as mutually decided between the Client and the Bidder. During each redundancy check, the plant operation shall not be disturbed and the control loops shall continue in auto mode. The trending of control parameters shall be in service during these checks and the over shoot / under shoot of the controlled parameters shall be less than 1%. These checks shall be logged (removal and relocation of modules/cables) in the system in addition to being made available to the operator in operator station.

Response time for each type of update as per the specification shall be checked on line by suitably recording each activity.

Performance parameters shall be checked and established. The stability tests for the control loops shall be checked for various load conditions viz. 75%, 50% and 25% and the variation in the process parameters shall be within the limits specified.

Checking of the time activated and on demand reports shall be done.

Functional interchangeability of the Operator Stations and printers shall be checked.

The calculations / documents earlier furnished for establishing the specified system availability, shall be demonstrated with due consideration for the running plant.

If the performance of the system deviates from the specification requirements, the Bidder shall be given a maximum period of 3 days depending on the gravity of the defect as mutually agreed, to carry out the modification without disturbing the plant operation.

Bidder shall declare the system fit for checking after completing the modification / rectification. The specific test shall be repeated for proper functioning.

During the test, any modules / equipment fails, the Bidder immediately within four hours shall replace the faulty module / equipment and the test shall be repeated after extended continuous running of 96 hrs.

The total duration for the site acceptance test shall not exceed 30 days including the repetition of tests and duration for replacement / rectification.

During all the above tests, Bidder shall ensure that the disturbance to the process is minimum.

The failure of any one of the hard or soft copy device shall not be taken as non-availability of the system. However, the mean time to repair shall not exceed that specified by the Bidder.

All the special equipment, tools and tackles required for the successful completion of the Performance test shall be provided by BIDDER as part of the total scope of services. Ready stock of all types of modules / PC boards shall be available as part of the total scope of services for immediate replacement during the period.

Proven product

The offered PLC / DCS system must have proven record of been successfully supplied, erected, tested and commissioned for some critical applications (in at least two sites in at least two units of similar or higher capacity boilers.)

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All C&I equipments/systems/subsystem/instruments and accessories shall be of make and model whose guaranteed and trouble free performance has been proven at least for 2 years in similar or higher capacity plant.

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14.0 TESTS AND INSPECTION

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General

After Manufacturing, all instruments shall be tested and calibrated at Factory. Bidder shall be responsible in obtaining test certificates related to calibration of all the Instruments and submit for Owner/Consultant approval. Bidder shall only allow dispatch of these instruments after passing Factory Acceptance test and approved by Owner/Consultant. The details of the tests to be carried out for the field instruments and control valves and specific test for control system shall be as indicated in the subsequent sections and any other tests as required by the Standards and Codes.

Type Test Requirements

- a) The Bidder shall furnish the type test reports of all type tests as per relevant standards and codes

Special Requirement for Solid State Equipments/ Systems

The type test reports, which are to be submitted for each of the major C&I systems like – PLC / DCS, Flame monitoring system, Boiler flame analyzing system, Coal bunker/Hoper level monitoring system, 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, and data links shall be provided with protections that meet 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.
- III. Damp Heat test as per IEC-68-2-3.
- IV. Vibration test as per IEC-68-2-6.
- V. Electrostatic discharge tests as per IEC 801-2 or equivalent.
- VI. Radio frequency immunity test as per IEC 801-6 or equivalent.
- VII. Electromagnetic immunity as per IEC 801-3 or equivalent.
- VIII. Type Test Requirement for C&I Systems

Item	Standard	Test to be specifically conducted?	Purchaser's approval req. On test certificate?	Remarks
Elect. Metering instruments	IS-1248	No	Yes	
Thermo-couple	IS-2147	No	No	
RTD	IEC-751	No	No	
Electronic transmitter	BS-6447 / IEC-770	No	Yes	
E/P converter	Mfr. standard	No	Yes	

Factory Acceptance Tests (FAT) for Control System Test requirements

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Test shall be performed with the completely assembled system and also with complete C&I software and performing all functions expected while in actual service and with system configuration as finalized.

Process input/output conditions and other loads on the system are to be simulated either by hardware/software.

All system software and application software shall be loaded and made operational on the system prior to FAT.

FAT shall be conducted at elevated temperature 45 °C for minimum 48 hours.

FAT shall be conducted for four cycles of voltage fluctuations viz. nominal at 110% of rated voltage.

Test documents / Drawings

- Total system configuration drawing
- FAT procedure consisting of:
 - a) Test equipment
 - b) Test environment
 - c) Test configuration
 - d) Test procedure
 - e) Test schedule
 - f) Test venue
 - g) Test report-specimen copies
 - h) Function design specification for each equipment /system

Preliminary checks

- General appearance check and bill of materials check
- Construction check as per over all general arrangement drawings
- Dimensional check
- Labeling, terminal arrangement and equipment identification check
- Power supply voltage level check
- Cooling fan operation check
- Grounding network check

Notes

The intent of the FAT is to demonstrate and ensure that the I&C system/equipments/instrument meets all the functional requirements as intended in the specification/contract. A completed integrated test of system shall be carried out at vendor /sub vendors works in the presence of owner/engineer, on completion of integration/manufacturing of the system the shipment of I&C equipment to site shall be affected only after the FAT has been accepted by the owner/consultant.

FAT procedure shall be prepared by vendor /sub-vender and to be submitted for owner/consultant approval well in advance prior to the commencement of FAT.

FAT Check List

System Level

- Power supply under voltage and over voltage check (=10%)
- Processor and main data bus network redundancy check if applicable
- Communication coupler if applicable redundancy checks
- Communication module of the controller to network redundancy checks if applicable.

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- Power supply redundancy check
- Hardware on-line maintainability check

Controller & MMI Level

- Closed loop control simulation check
- Open loop control simulation check
- Control loop response check
- Bumpless auto manual transfer check
- MONITOR-graphic overview check
- MONITOR -trend check
- MONITOR -real time trend check
- MONITOR -mimics check
- MONITOR -check for operating control directly from mimics
- MONITOR -function keys check
- MONITOR -touch screen function check
- MONITOR -analog control display check
- MONITOR -sequence control display check
- MONITOR -operator guidance message check
- MONITOR –alarm management function check
- MONITOR – logging function check
- MONITOR /response/updating/check
- Keyboard lock function check
- MONITOR interchangeability and assignability check.
- Printer assignability and backup function check
- Disk/std/hard disk unit storage and retrieval check
- MONITOR assignability check for hard copier function
- Communication interface others system simulation check

Maintenance Level

- System security check
- System alarm check
- System diagnostic function check
- Point detail configuration check
- Control loop tuning check
- System loop documentation check

Notes

- FAT shall be conducted with the cables required between the processor and other supporting Peripherals shall be laid in line with final layout requirements

Tests to be Performed for Field Instruments

1. Pressure indicators
Calibration Hydro test (1.5 times max. pr.)
2. Pressure switches
Calibration test / Hydro test / Contact rating test / Accuracy test / Repeatability
3. Differential Pressure Indicators
Calibration test / Hydro test / Leak test / over range test / Accuracy test / Repeatability test.
4. Differential Pressure Switches
Calibration test / Hydro test / Contact rating test / Leak test / Accuracy test / Repeatability test.

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5. Thermometers
Calibration / Material test / Accuracy test / Bore concentricity: + 5% of wall thickness / Hydrostatic test for TW (1.5 times max. pr.)
6. Temperature switch
Calibration / Material test / Accuracy test / Bore concentricity: 1.5% of wall thickness / Hydrostatic test for TW (1.5 times max. pr.) / Contact rating test.
7. Resistance temperature detector assembly
Calibration / Material test / Bore concentricity test / Insulation test (< 500 Mohm at 500V DC) as per ISA, Hydro test for TW. Bore concentricity: + 5% of wall thickness, Accuracy test.
8. Thermocouple assembly
Calibration / Material test, Insulation test (> 500 Mohm at 500 V, DC) as per ISA, Hydro static test (1.5 times max. pr.), Bore concentricity: + 5% of wall thickness.
9. Thermo wells
Material test / Bore concentricity: + 5% of wall thickness / Hydrostatic test for TW (1.5 times max. pr.)
10. Level Gauges
Hydrostatic test / Material test / Seat leakage test / Ball check test.
11. Level switches (Magnetic)
Material test / Contact rating test / Hydro test / Calibration test.
12. Flow Switch
Material test / Hydrostatic test (1.5 times max. pr.) / function test.
13. Flow glasses
Material test / Hydrostatic test (1.5 times max. pr.) / function test.
14. Variable area flow meters
Calibration test / Material test / Hydrostatic test (1.5 times max. pr.)
15. Flow element
100% Radiography test / Hydro test / Calibration test, IBR Certificate. Calibration test for flow element may be witnessed by Owner/Consultant.
16. Control valves/Pneumatic block valve/Pressure regulating valve.
17. Position transmitters
Calibration / hysteresis and Accuracy test
18. Electro Pneumatic Convertors
Calibration test / Accuracy test
19. Air filter regulators
Calibration test / Accuracy test
20. Junction Boxes
Test for degree of protection / Material test

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21. Tests for terminal blocks
Test for molding for flame resistant, Non-hygroscopic and Decarbonized/ Insulation test between terminals / Insulation between terminal block and frame.
22. Thermocouple extension cable
Thermo-emf characteristic / Continuity test / Measurement on capacitance, inductance and loop resistance / Insulation resistance / High voltage test as per latest IS / Tensile and elongation test / Oxygen index test / Any other test applicable.
23. Mass flow meter
Performance test / Calibration test / Hydrostatic test.
24. Boiler Drum Level Gauge
Hydrostatic test / Material test / Seat leakage test / IBR Certificate
25. Interposing relay
Functional test, temperature rise test, H.V test, Insulation test
26. Transmitter Racks
Hydro test, air leak test for piping / tubing and fittings. IBR certification as required for Tubing / piping and fittings.
27. Local Panels
Visual inspection, wiring & continuity check, H.V. and I.R. tests on panels, checking of bill of materials, functional tests.

Site Functional Tests

After the installation of Instruments, before taking in to service, all impulse lines sampling lines and air supply lines shall be blown with adequate line pressure and temperature conditions to keep the lines thoroughly clean to the satisfaction of Owner / consultant. Blowout of these lines & commissioning of the Instruments shall be repeated many times till all the lines are taken for continuous operation. Once the Instruments are taken to service, BIDDER shall physically inspect the various points & pipes for leakages and take-up repair work to verify the faults. On line calibration of the Positioners & Stroking of Control Valves/ Control dampers shall be carried out during control system tuning.



Bidder shall conduct the following site functional test of the control system and packages control system.

- Calibration of monitoring and control equipment
- Integrated loop test wiring, Simulation input from site

After the control & instrumentation system is completely installed as per specification requirements. The control & instrumentation system shall be kept on trial operation / Total Integration test in the presence of the Owner / consultant. for a duration of 14 days out of which 72 hours shall be continuous operation performing all the functions as specified. The trial operation shall be considered successful provided that each item of equipment can operate continuously at the specified characteristics for the period of trial operations. During this period, any modifications / repairs as required shall be carried out. If the total interruption period is more than 4 hours, the trial operation duration shall be extended by the period of interruption.

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15.0 SPARES

			
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SPARES

15.1 RECOMMENDED SPARES

The Bidder shall provide based on his own experience of the performance of his equipment, in the form of a schedule given in Bid Proposal Sheets, the complete list of recommended spare parts for three (3) years operation of the equipment covered under the proposal. The recommended spare prices shall be firm and shall not be subject to escalation and shall not be included in the total price but indicated separately in the schedules. In the list of recommended spare parts, the Bidder shall identify the for one Boiler wise population along with price break-up of each of the items recommended and anticipated normal life of the spares. The Owner has the option to either procure the recommended spares along with main equipment or later on.

The prices of recommended spares quoted by the Bidder shall remain valid one up to one (1) year from the date of Commissioning and the Owner shall have the right to place the order of spares up to one (1) year period from the date of Commissioning at the same price. The prices of all future requirements of spares beyond one (1) year period will be mutually agreed but such prices shall, in no case, be higher than those agreed with the most preferred customers.

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16.0 CODES AND STANDARDS

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All equipment, systems, software and services covered under this Specification shall comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment shall be installed. All codes and standards referred to in this specification shall be understood to be the latest version on the date of offer made by Bidder unless otherwise specified. If such standards do not exist for any equipment or system, the same shall comply with the applicable recommendations of the following professional institutes:

- National Electricity Manufacturers Association (NEMA)
- The Institute of Electrical and Electronic Engineers (IEEE)
- Instrumentation, Systems and Automation society (ISA)
- American National Standards Institute (ANSI)
- Deutsche Industries Normen (DIN)
- International Electrochemical Commission (IEC)
- Verein Deutscher Eisenhüttenleute (VDE)
- Japanese Industrial Standards (JIS)
- American Society of Testing and Materials (ASTM)
- American Society of Mechanical Engineers (ASME)
- American Petroleum Institute (API)
- Standards of the Hydraulic Institute, U.S.A.
- International Organization for Standardization (ISO)
- American Welding Society (AWS)
- National Fire Protection Association (NFPA)
- International Electro-Technical Commission (IEC)
- Expansion Joint Manufacturers Association (EJMA)
- Heat Exchange Institute (HEI)
- Indian Standard Institute (ISI)
- Indian electricity act
- Indian electricity rules
- Indian Explosives Act
- Indian Factories Act and State Factories Act
- Indian Boiler Regulations (IBR)
- Regulations of the Central Pollution Control Board, India
- Regulations of the Ministry of Environment & Forest (MoEF), Government of India
- Pollution Control Regulations of Department of Environment, Government of India
- State Pollution Control Board
- Rules for Electrical installation by Tariff Advisory Committee (TAC)

Standards not indicated in the specification are acceptable subject to approval by the Owner / consultant if they are established to be equal or superior to the standards indicated in the specification. The Bidder shall furnish English translation of all standards to which the equipment and systems offered conform to:

Instrumentation Symbols and identification	ISA S 5.1
Binary logic diagrams for process operation	ISA S 5.2
Graphic symbols for CONTROL SYSTEM, shared display inst.	ISA S 5.3
Logic and comp. System	
Annunciator sequences and specification	ISA S 18.1

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Environmental conditions	ISA S 71.04
Control valve sizing	ISA S 75.01
Control valve procedure capacity test	ISA S 75.02
Vibration, Axial Position & Bearing	API 670
Valves Seal Leakage	ANSI B 16.104
Thermocouples	ANSI MC 96.1
Measurement & Control, Electrical sensors	DIN 19243
Industrial RTD	DIN 43760/ IEC751
Air Purge System	ISA S 12.4/NFPA 456
Measurement of Fluid Flow by Meter Run	ISO 5167
Temperature Measurement	ANSI MC 96.1/IEC751
Degree of Protection by Enclosure	IEC 529

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17.0 WARRANTY

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The Bidder shall provide an unlimited warranty on all equipment and software for one year after the start of the warranty period, i.e. after satisfactory completion of operations. This warranty shall include repair, replacement or correction of identified software or hardware discrepancies at no cost to the Owner.

The Owner shall normally carry out no repairs/replacement when the plant is under the supervision of Bidder's supervisory engineers. If in the event of any emergency, in the judgment of the Owner, delay would cause serious loss or damage, the Owner or a third party chosen by the Owner without advance notice to the Bidder may make repairs and the Bidder shall pay the cost of such work.

The Bidder shall provide warranty spares and an exhaustive list of warranty spares including components for system hardware and instrumentation and peripherals based on (and keeping adequate margin over) normally experienced failure rate shall be submitted by the Bidder for Owner's review regarding adequacy of the same. The Bidder along with the main equipment consignment will dispatch the warranty spares. The Bidder shall also provide expandable items for the warranty period.

In case of any hardware failures, which hamper normal operation, the Bidder during the warranty period must provide on-site technical expertise to repair/rectify the problem within a week and if any component is not available at site, the Bidder must arrange to supply these components at site within additional 48 hours. If a software problem is identified, this problem shall be corrected within two weeks.

After six months of Control system operation the Bidder shall provide the list of parts and expendables utilized for the period for all C&I systems and equipments. The same information will be provided at the conclusion of the warranty.

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18.0 DOCUMENTATION

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General

The Bidder shall prepare an exhaustive Master Drawing List (MDL) of all drawings/documents/manuals to be submitted during detailed engineering stage (including those from sub-vendors). The MDL shall contain drawing/document no., rev. no., title, scheduled date of submission, actual date of submission, approval status (Category & date), etc. The exact format shall be as approved by Owner. The Bidder shall furnish the MDL to Owner before Notification of Award (NOA). This shall be discussed and finalized during pre-award discussions. The MDL will be modified by Bidder periodically to take care of detailed engineering requirements. The MDL shall be submitted by Bidder for Owner's information every month with latest status. Five copies of all the drawings/documents/manuals shall be submitted in hard as well as soft copies.

Control System

Following Documentation shall be furnished in hard as well as soft copies:

Detailed standard technical literature for all types of modules, peripherals of Control system & PLC / DCS.

User guide/details for

- i. Diagnostic stations & diagnostic facilities
- ii. Programming stations & programming facilities
- iii. System documentation facilities

List of all types of software used in MMI, Control system, Programming & Documentation Stations, etc.

Details of all types of functional software blocks available in the system for developing control loops/logics.

Details of standard & customized applications in MMI.

Details of symbols used in graphic displays/mimics in MMI.

Bidder's standard formats for database and other displays for Owner's inputs.

Preliminary Design Documents

Overall configuration diagram of PLC / DCS based Control system showing all components / modules. Detailed functional grouping diagram of Control System showing distribution of drives, calculations showing capabilities (including spare capacity) of each group.

Bill of Material (BOM) of Control system indicating no. of system cabinets, marshaling cabinets, relay cabinets, peripherals etc. with weight, heat load, degree of protection of each item.

Outline & mounting drawings for all types of cabinets, peripherals in Control system



Floor opening requirements in Central Control Room, Control Equipment Room, Marshaling Room, Programmer's Room, Shift Supervisor's Room and other places where Bidder's cabinets/equipment is to be located.

Detail Design Documents

Functional Design Specification for PLC / DCS based Control system containing:

Design philosophy for Control system indicating how the specification requirements are translated in Bidder's system, implementation philosophy, redundancy features, etc.

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Write up on the system offered and as configured & customized for this project.

Write up on MMI elaborating

System/operator functionalities for displays, logs, calculations, historical storage, long term storage, LAN, WAN, etc.

Various application engineering details.

System security

Redundancy features

Parametric requirements

Programming requirements

Diagnostic facilities

Connectivity with LAN/WAN

Alarm reporting

Write-up on Computation logic for alarm annunciation functions

Single line diagram for power supply requirements and distribution scheme of control system.

Grounding Scheme for control system.

Standard O&M manuals & programming guides e.g. for data base, mimics, logs, HSR, etc. in MMI.

Calculations to show how system spare capacity & expandability requirements as specified are being met in Bidder's system.

Calculations to show how system parametric requirements as specified are being met in Bidder's system.

Calculations to show how system availability requirements are being met in the offered configuration of Control system and details of MTBF/MTTR figures for each component of Bidder's system.

Detailed BOM of Control system with quantities for each of the subsystems, the detailed BOM shall be furnished for each cabinet & peripheral indicating quantity, make, model, part no., ordering code for each part/component so that based on this information Owner can procure these parts/components, if required later.



Documents Supplied with the Equipment

Operation and maintenance manuals and diagnostics/trouble shooting guides for all equipment/devices of Control system, The manuals shall include all information required for trouble-shooting, repair and maintenance information regarding all the equipment furnished for the completeness of the system including on-line insertion/removal of all types of modules. Sufficient documentation shall be provided to carry out trouble-shooting and repair of all electronic cards (PCBs), power supply modules, etc. at component level. Installation & Commissioning manuals.

Software listings including source CD-ROMs for application system software and any changes from system software earlier submitted, system generation discs, on-line/off-line diagnostics programs, software system maintenance manuals, special to project data files and any other document not listed specifically here but required to understand, trouble-shoot, repair, maintain the offered system.

C&I Documentation covering SG

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Detailed I/O list giving complete connectivity of input & outputs, This shall include tag no., TB no., cable no., marshaling rack/pin no., functional group, system cabinet no., I/O module location, channel no., related loop/logic drawing no., process range, alarm limits, set points, use of signal for interlock/protection/sequence/control loop/SOE/annunciation/information only etc., destination details for output signals including system cabinet no., I/O module no., channel no., Cable no., etc. The exact no. of fields in the list shall be as approved by Owner during detailed engineering stage.

Control loop & logic diagrams for all control systems.

MMI displays, mimics, logs, reports, etc. Alarms list.

I/O list, instrument schedules.

Data sheets of field instrument/control valves/flow elements etc.

Cable schedules, interconnection diagrams.

General Arrangement, Internal Arrangement of all panels and cabinets.

Instrument Installation Diagrams

Interfacing details indicating interfacing arrangement of Bidder's system with other systems not in Bidder's scope.

Interconnection schedule (ICS) showing complete system connectivity right from field instruments/devices/MCC/SWGR/actuators to individual channels of input modules and system outputs from individual output channels to relay cabinets/MCC/SWGR/actuators, etc. irrespective of scope of supply of instruments/devices/actuators & cables.

Detailed System Generation (Sys-Gen) procedures, i.e. the process of finally integrating all programs and data modules in to a single system module.

Schematic, logic diagrams etc. for PLC / DCS based control system etc.

As Built Drawings

All changes made to the system after its dispatch from the works shall be reflected in the related documents and those revised documents shall be handed over to the Owner in required number of copies. (As-built drgs along with NFPA literature)

Measuring Instruments

- Complete Bill of material for all instruments including all necessary accessories etc.
- Instruction manual covering instructions for installation, calibration, commissioning, normal operation, trouble shooting and maintenance for all instruments furnished by the Bidder.
- Test certificates of all instruments.
- Installation drawings for instruments and measurement systems furnished along with details of erection material furnished.
- Connection and interconnection wiring diagrams.

Test Equipments

- Complete Bill of Material for all items furnished including all the accessories provided.
- Detailed description of each equipment furnished.
- Design specification sheet of each type of equipment furnished.

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- Instruction manual covering mounting, operation, calibration, trouble shooting and maintenance, etc., as applicable for each type of equipment furnished.
- Test certificate for each equipment furnished.
- Certified temperature curve and other calibration curves/data as applicable to equipments furnished.
- List of spare parts furnished.
- Availability of spare parts.

UPS, DC Power Supply

- Complete Bill of Materials for all uninterruptible power supplies & DC power supply system equipment and system components including associated accessories.
- Detailed description of each type of device/instrument furnished for UPS system & DC supply system.
- Design specification sheet for each type of system hardware/instrument.
- Write up on uninterruptible power supply system including descriptions for start-up/shut down procedures, normal operation etc.
- Calculations for sizing of inverters, batteries, battery charger, transformer etc.
- Detailed circuit diagrams of the chargers, inverters, static switches etc., including the circuit diagrams of various printed circuit boards for facilitating maintenance of UPS by Owner.
- Specifications, ratings etc., of various components/devices including international code numbers which will enable the Owner to procure these components/devices from sources other than the original system supplier.
- Instruction manual covering instructions for installation, testing, commissioning, normal operation, trouble shooting and maintenance for each type of UPS system & DC power supply system hardware furnished and for the system as a whole.
- Outline and mounting drawing showing dimensional details for all UPS cabinets/enclosures.
- General arrangement, layout drawings for all UPS cabinets/enclosures.
- AC & DC distribution board general arrangement, layout assembly and mounting drawings.
- Wiring diagrams showing connections between terminal board and the devices/instruments, for all UPS system cabinets.
- Wiring diagrams for AC & DC distribution boards.
- All terminal board drawings required to define input/output connections for the Uninterruptible Power Supply System.
- Uninterruptible Power Supply System schematic diagrams and power distribution single line diagram giving feeder ratings.

Impulse Piping and Erection Hardware

Bill of Materials for impulse piping, sample piping, pneumatic tubing, fittings, instrument valves, valve manifolds, tubing trays and all other accessories required for erection.

Detail dimensional drawings showing parts and material specification for process connection, instrument valves, valve manifolds, fittings, etc.

Local Instrument Enclosures/Racks

- Following data/drawings shall be submitted for the transmitter enclosures/racks:
- Outline and mounting drawings for transmitter enclosure/racks.
- Tubing and electrical wiring layout drawings for transmitter enclosures/racks.
- Instrument installation detail drawing showing instrument location, mounting within enclosure/rack, floor opening (if any).

Cabling

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- Complete Bill of Materials for all types of instrumentation cable and electrical field construction material and accessories.
- Detail technical specifications for cables, and wiring conduit and fittings, junction boxes; terminal blocks and other electrical installation materials furnished by the Bidder.
- Cable schedules & interconnection diagrams for all cables furnished by the Bidder.

Control Desk, Panel



- Complete Bill of Material for all control desk, panels, desk mounted items. The Bill of Material shall include the accessories associated with panel mounted items.
- Power supply requirements for all equipment.
- Outline and dimensional drawings for control desk, shift charge engineer's etc.
- Control desk, panels internal wiring diagrams applicable to all electrical devices mounted on the panels/desk, between the devices and from the devices to terminal blocks.
- Connection and interconnection wiring diagrams.
- Interconnection diagrams for all cables required for interconnection of equipment furnished by the Bidder and for interconnection of Owner's equipment/system to equipment/system furnished by the Bidder.

Documents to be submitted along with BID

- The bidder shall submit the following documents along with the bid as minimum:
- Control room Layout
- GA of Control Desk & panel
- PLC / DCS Configuration diagram
- Technical write up & detailed description of the C&I system offered.
- Filled up Data Sheets
- Bill of materials with catalogues of complete C&I systems
- Other Documents as specified in various sections of the specification
- Deviation, if any from the specification clauses.
- Master drawing list (MDL) for C&I.

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19.0 TRAINING

			
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Training for C&I Staff

Bidder shall provide the training to Customer C&I Staff in the following areas at OEM works. No. of staff members to be trained shall be at least 50 mandays in two groups of 05 engineers for 05 days each.

Software

- PLC / DCS Programming
- Troubleshooting
- System Loading & Start-up
- Operation from Control System Operator screen
- Navigation between screens
- Alarm Handling

Hardware

- Troubleshooting

Training for Operating Staff

Bidder shall also provide the training to Customer Operating Staff in the following areas. No. of Operating Staff to be trained shall be at least 100 mandays at site.

- Control System Configuration and Maintenance
- System hardware Familiarization and Troubleshooting
- Operation from Control System
- Alarm Handling and Event Handling
- Data Acquisition System and Maintenance training

Training has to be provided to Owner's personnel in Flame Scanners for Hardware & Software System.

Bidder's personnel at site shall continuously and intensively instruct and train adequate number of Owner's Operating and Maintenance personnel at site during erection and commissioning of the equipment to enable them to take over the proper operation and maintenance of equipments, Control & Instrumentation system after commissioning.

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20.0 DATA SHEETS – A

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DATA SHEETS

Data Sheet – A for Electronic Transmitter - Pressure, D.P., Flow, Level

S. No.	Features	Essential/Minimum Requirements
1.	Make	Bidder to state
2.	Model No.	Bidder to state
3.	Type of Transmitter	Micro-processor based 2 wire, (loop powered) Smart type, indicating (LCD display)
4.	Accuracy	± 0.075% of span (minimum) or better
5.	Output signal range	4-20 mA DC (Analog) along with superimposed digital signal (based on HART protocol)
6.	Turn down ratio	Vacuum/very low pressure - 10:1 and other applications - 30:1.
7.	Zero and span drift	+/- 0.015% per °C at max span. +/-0.11% per °C at min. Span
8.	Load impedance	500 ohm (min.)
9.	Stability	± 0.1% of calibrated span for one year for ranges up to and including 70 Kg/cm ² .
10.		± 0.2% of calibrated span for one year for ranges more than 70 Kg/cm ² (g).
11.	Housing	IP-65
12.	Over Pressure	150% of max. Operating pr.
13.	Connection (Electrical)	Plug and socket type
14.	Process connection	1/2 inch NPT (F)
15.	Adjustment/calibration/maintenance	Continuous, tamper proof, Remote as well as manual adjustability from instrument with zero suppression and elevation facility.
16.	Accessories	Diaphragm seal, pulsation dampeners, Siphon etc. as required by service and operating condition. 2 valve manifold for absolute pressure transmitters (3-valve manifold for gauge/ vacuum pressure transmitters) and 5 valve manifold for DP/level/flow transmitters.
17.	Diagnostics	Self-Indicating feature
18.	Power supply	24V DC
19.	Repeatability	+ 0.05% of span or better
21.	Response time	Min. 100 ms

Notes:

- 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. For HFO, LFO Applications, SS capillary with thin wafer element with ANSI RF flanged ends are to be provided.

Data Sheet – A for Temperature Gauge

S. No.	Features	Essential/Minimum Requirement
1.	Make	Bidder to state

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S. No.	Features	Essential/Minimum Requirement
2.	Model No.	Bidder to state
3.	Sensing Element and material	Below 450°C - Mercury in steel Above 450°C - inert gas actuated of SS bulb and capillary.
4.	Body material	SS
5.	Dial size	150 mm
6.	End connection	3/4" NPT (F)
7.	Accuracy	± 1% of span
8.	Scale	Linear, 270° arc graduated in °C
9.	Range selection	125% of max. of scale
10.	Housing	IP-65
11.	Zero/span adjustment	Provided
12.	Identification	Engraved with service legend or laminated phenolic name plate
13.	Accessories	SS Thermo well
14.	Material of Bourdon/ movement	316 SS / 304 SS
15.	Repeatability	Less than 0.5% of FS.
16.	Response Time	40 seconds
17.	Over range Protection	120% up to 400 Deg. C 115% above Deg. C
18.	Others	Capillary and case compensation zero adjusting by screw from front.

Data Sheet – A for Pressure and D.P. Gauges

S. No.	Feature	Essential / Minimum Requirement
1.	Make	Bidder to state
2.	Model No.	Bidder to state
3.	Sensing Element	low pr./ vacuum - diaphragm or bellows high pressure - Piston actuated
4.	Material	AISI 316 SS
5.	End connection	½ inch NPT (F)
6.	Over range proof pressure	150% of max. design pr.
7.	Repeat-ability	± 0.5% of full range
8.	No. of contacts	2 No.+2NC. SPDT snap action dry contact
9.	Rating of contacts	0.2 A at 220 V DC
10.	Elect. Connection	Plug in socket
11.	Set point/ dead band adjustment	Provided over full range
12.	Enclosure	IP-65
13.	Accessories	Snubber, chemical seal, pulsation dampeners as required by process
14.	Mounting	Suitable for enclosure/ rack mounting or direct mounting
15.	Switch Type	Snap acting micro switch, shock & vibration proof.

Data Sheet – A for Level Gauges

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S. No	Features	Essential/Minimum Requirement
1.	Make	Bidder to state
2.	Model No.	Bidder to state
3.	Sensing Element and material	Toughened Borosilicate gauge glass steel armored reflex or transparent type.
4.	Body material	AISI 316 SS (liquid chamber), Tempered Borosilicate (glass)
5.	End connection	Process connection as per ASME PTC and drain/vent 15 NB
6.	Accuracy	± 2%
7.	Scale	Linear vertical
8.	Range selection	125% of max. of scale
9.	Over range test	150% of the max. design pr.
10.	Housing	CS/304 SS leak proof
11.	Identification	Engraved with service legend or laminated phenolic name plate
12.	Visible Length	Shall cover the complete tank height.

Notes:

- Bicolor type level gauges will be provided for applications involving steam and water except for 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.
- For drum type Boiler, two illuminated multi-port (one lamp per port) suitable for process pressure and temperature conditions for local indication, one at either end.

Data Sheet – A for Control Valves

S. No.	Description	Requirement
1.	Make	Bidder to state
2.	Model No.	Bidder to state

S. No.	Service	Body material	Trim Material
1	Non-corrosive, non-flashing and non-cavitations service	Carbon steel ASTM-A216 Gr. WCB for fluid temperature below 275 Deg. C	316SS steelited with stellite faced guide posts and bushings.
		Alloy steel ASTM-A217Gr. WC9 for fluid temperature above 275 Deg. C	
2.	Severe flashing/cavitations services	Alloy steel ASTM-A217 Gr. WC9	440 C
3.	Low flashing/cavitations service	Alloy steel ASTM-A217 Gr. WC6	17-4 PH SS
4.	Condensate, DM water service	316 SS	316 SS
	Features	Essential/Minimum Requirement	
5.	Fluid	As per service	

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S. No.	Service	Body material	Trim Material
6.	Valve Size	Bidder to state	
7.	Rating (ANSI)	2500	
8.	Cv	Bidder to state	
9.	Body	Type	Globe
		Connection	Butt Welded
10.	Bonnet	Type	Standard/ as per service
		Packing	Graphite/ Bidder to state
		Lubricator	As required
11.	Trim	Plug Type	Manufacturer's standard
		Cage Type	Linear/ Equal %
		Guiding	Cage
12.	Flow to Open/Close	As per service	
13.	Leakage Class	Class IV/V as per ANSI B 16 104	
14.	Opening at maximum flow	80% approx.	
15.	Opening at minimum flow	10% approx.	
16.	Overall Noise	85 (dbA) maximum at 1 meter from service.	
17.	Fluid outlet velocity	6 m/sec.(maximum) for Liquid service.	
		150 m/sec for Steam service.	
		50%of Sonic velocity for flashing service.	
18.	Codes & Standards	ISA S39.2-1972 (Incompressible Fluids)	
		ISA S39.4-1974 (Compressible Fluids)	
19.	Actuator	Pneumatic Spring Diaphragm/Piston type.	
		Stem/Piston Rod-ANSI 304	
		Diaphragm Material-Neoprene	
		Stem force of at least 0.15 Kg/sq.cm. per linear millimeter of seating surface, shall be provided in the selection of the actuator to ensure tight seating.	
20.	Smart Positioner	Stroke Adjustment-Shall be possible.	
		Gauges- Supply, Signal, output	
		Travel time of valve- <10 seconds	
		Input-0.2 to 1.0 bar	
		Hysteresis - ±0.5% of F.S.	
		Linearity - ±1.0% of F.S.	
		Dead Band - ±0.5% of F.S.	
21.	I/P Converter	Input 4-20mA DC, Output 0.2 to 1.0 bar	
22.	Other Accessories		
	Position Transmitter	Yes, 4-20mA DC Output	
	Limit Switches	Yes	
	Solenoid Valve	As required	
	Air Set	Yes	

Note:

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- Valve body rating shall meet the process pressure and temperature requirement as per ANSI B16.34.
- Bidder to furnish CV values for all valves.

Data Sheet – A for Impulse Piping, Tubing, Fitting, Valves, Manifolds

S.No	Quantity of Root Valve	Size of stub and root	Service Condition valve
A. Pressure and Differential Pressure measurement			
(i)	2	25 NB	>=40 bar OR 300°C
(ii)	1	15 NB	<40 bar AND 300°C
B. Pressure and Differential Pressure (Oil System)			
(i)	2	25 NB	>=40 bar OR 300°C
(ii)	1	25 NB	<40 bar AND 300°C
C. Level measurement			
a) Level Gauge & Switch			
(i)	2	25 NB	>=40 bar OR 300°C
(ii)	1	25 NB	<40 bar AND 300°C
b) Level transmitter (displacement type)			
(i)	2	40 NB	>=40 bar OR 300°C
(ii)	1	40 NB	<40 bar AND 300°C
c) Stand pipe for level measuring instrument			
(i)	2	80 NB	>=40 bar OR 300°C
(ii)	1	80 NB	<40 bar AND 300°C
d) Flow measurement			
(i)	2	25 NB	>=40 bar OR 300°C
(ii)	1	25 NB	<40 bar AND 300°C
e) Sampling system measurement (steam & water service)			
(i)	2	25 NB	>=40 bar OR 300°C
(ii)	1	25 NB	<40 bar AND 300°C

Data Sheet – A for Indicators

S. No.	Features	Essential/minimum requirements		
		Digital indicator	Vertical indicator	
1.	Make	Bidder to state	Bidder to state	
2.	Model No.	Bidder to state	Bidder to state	
3.	Type	4½ digit LED seven segment display.	Permanent Magnet Moving, Coil, (PMMC) single element with strip scale	
4.	Input signal	4-20 mA DC	4-20 mA DC	
5.	Display character	14 mm size decimal continuous reading	Analog linear with pointer	
6.	Accuracy	± 0.1% of full scale(at 20 0C -30 0C) ± 2 LSD	± 1% of full scale	
7.	Response time	250 m sec.	2 sec. (full span)	
8.	Signal Connection	Screwed	Screwed	
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S. No.	Features	Essential/minimum requirements	
9.	Power Connection	Screwed	N/A
10.	Zero/span adjustment.	Shall be possible from the front of instruments.	
11.	Power supply	240V AC	N/A
12.	Power supply fuse connection	Yes	N/A
13.	Mounting	Fully compatible to the mosaic grid	Fully compatible to the mosaic grid
14.	Protection class	IP-20	IP-20
15.	Identification	-----Engraved Phenolic tag -----	
16.	Dimension	96 mm (W) x 48 mm (H)	36 mm (W) x 144 mm (H)

Data Sheet – A for C&I Cables

Conductor Size				
Parameter/ Type of Cable	Individual and overall shielded (Type F)	Overall Shielded (Type-G)	Individual and overall shielded Teflon Coated (Type I)	Extension cable (with/without Teflon coating) (Type A, B, C)
Mutual capacitance at 0.8 kHz (max.)	120 nF/Km.	100 nF/Km.	2. 120 nF/Km; 100 nF/Km.	200 nF/Km
Conductor Resistance (max.)	73.4 ohm/km (loop) For Type F	73.4 ohm/km (loop)	73.4 ohm/km (loop)	
Insulation resistance	100 M ohm/ Km	100 M ohm/ Km	100 M ohm/ Km	100 M ohm/ Km
Cross-Talk figure at 0.8 kHz (min.)	60 dB	60 dB	60 dB	3. 60 dB
Characteristic impedance (max.)	320 ohm	340 ohm	320 ohm; 340 ohm	
Attenuation at 1 kHz (max.)	1.2 dB/Km for Type F	1.2 dB/Km for Type G/0.8 dB for Type E	1.2 dB/Km	

Description of Various Types of Cables

Type	Description
A	Two pair shielded and twisted pair T/C extension cable, ANSI type KX, stranded copper conductor.
B	Two pair shielded & twisted T/C extension cable ANSI type SX, stranded copper conductor.
C	Two pair shielded & twisted heat resistant Teflon insulation & Outer sheath T/C extension cable ANSI type KX, stranded copper conductor.
F	Multi pair individual pair & overall shielded twisted pair instrumentation cable (4/8/12/16/20/24 pair) for analog signals with stranded copper conductor.
G	Multi pair overall shielded & twisted pair instrumentation cable (2/4/8/12/16/20/24/48 pair) for binary signals with stranded copper conductor.
I	Type F cable/type G cable with heat resistant Teflon insulation & outer-sheath for high temperature application.

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Data Sheet – A for Printers

S. No	Features	Color Laser Printer (A3)	Laser Printer (A4)	Color Inkjet Printer	Line Impact Dot Matrix Printer
1.	Make	Bidder to state	Bidder to state	Bidder to state	Bidder to state
2.	Model No.	Bidder to state	Bidder to state	Bidder to state	Bidder to state
3.	Paper Size	A3	A4	A4	132 column continuous fan fold type
4.	Printing Speed (min.)- in normal mode for A4 size paper	6 ppm (Color)	16 ppm (B&W)	3 ppm (Color)	1000 LPM
		24 ppm (B&W)		8 ppm (B&W)	
5.	Type	Heavy duty, atleast 50000 pages/month	Heavy duty, at least 30000 pages/month	Medium duty, at least 10000 pages/Month	Heavy duty, at least 50000 pages/month
6.	Resolution (black) (min.)	600 dpi	600 dpi	600 dpi	-
7.	First page out time (with full graphic display)	=<1 min for color,	=<1 min for color,	=<1 min for color,	
		<45 sec for BW	<45 sec for BW	<45 sec for BW	
8.	Paper input capacity (min.)	3000 sheets	500 sheets	300 sheets	Continuous paper feed
9.	Additional features	Automatic Duplex Printing			With printer Stand & sound proof enclosure (<60 dB)
10.	Paper sheets (1 ream = 500 sheets) with each printer	20 reams (A3)	20 reams (A4)	5 reams (A3)	20 reams (A3)
		20 reams (A4)		5 reams (A4)	(132 column fan-fold)
11.	Additional Cartridge/toner/ ribbon of each type as used in printer with each printer	1	1	2	100
12.	Communication ports	Ethernet Port (Network Ready Printer) in addition to standard parallel port			

Data Sheet – A for UPS

S. No.	Description	Units	Requirements	
1.	Type		Static Parallel redundant UPS with static by pass to regulated supply.	
2.	Power rating at load p.f 0.8 lagging		By Bidder	
	Application		For supplying the load of I& C	
3.	Installation /paint shade		Indoor, natural ventilated, shade 631 of IS-5 / RAL 7032 / eqt.	
4.	Input supply		415V, 3 ph, 50 Hz AC supply	
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S. No.	Description	Units	Requirements
	Output Voltage		230V, 1 phase, 50 Hz AC supply
5.	AC Voltage accuracy (steady state) over entire load PF &		By Bidder
6.	Range of adjustment of AC output		±5% at rated load voltage
7.	AC harmonic content		5% total, 3% for any signal harmonic
8.	Design Ref. Ambient	°C	50
9.	Standby AC supply with isolation Transformer and servo controlled voltage stabilizer		Same as UPS rating
10.	Rating		230V, 1 PH, 50Hz AC supply
10.1	Type		Dry type, Two winding
10.2	Ratio & frequency		By Bidder
10.3	Automatic voltage regulator Percentage voltage regulation • Transient response • Output voltage setting range	% % %	Required (servo-controlled) ±2 ±10 for bypass ±5 of nominal voltage
	Bypass transfer selection		Auto/manual switch
11.	Manual bypass PBs		Load to bypass load to inverter
12.	Manual bypass switch		Required
13.	Synchronizing between inverter and standby supply Static switch		Required ±2.5Hz (47.5Hz to 52.5Hz)
14.	Type	Type	Static
15.	Maximum transfer time		Maximum of 1/4 cycle

Data Sheet – A Ultrasonic Level Transmitter

S. No.	Features	Essential/minimum requirements
1.	Principle	Detection with reflected ultrasonic Operation pulse
2.	Measuring Ranges	Up to 30 meters (typical)
3.	Signal Processing	Microprocessor Controlled Signal Processing
4.	Operating Freq.	10KHz to 50 KHz (typical)
5.	Calibration & Configuration	Accessible from front of panel
6.	Power supply	240 V AC 50 Hz / 24V DC
7.	Signal Output	4-20 mA DC (isolated) - 600 Ohm load
8.	Hysteresis	fully adjustable preferred
9.	Output contacts	2SPDT
10.	Accuracy & Repeatability	0.25% of span or better
11.	Resolution	0.1% of span
12.	Operating temp.	Transmitter-50 o C and Sensor – 80 o C
13.	MOC Sensor	PVC and Face – Polyurethene
14.	Enclosure	P-65
15.	Cable Connection	3/4" ET
16.	Display	Large alpha-numeric back lit LCD/LED
17.	Accessories like Cable gland, prefab	Cable gland, prefab cable, mounting accessories

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S. No.	Features	Essential/minimum requirements
	cable, mounting accessories	etc.

Data Sheet – A Radar Level Transmitter

S. No.	Feature	Essential / Minimum Requirement
1.	Type	Guided Wave Radar
2.	Application	Bunker level measurement
3.	Probe Type	As required for the application Co axial / single rod type guided wave or Horn type
4.	Probe Material	SS 316L
5.	Accuracy	+/- 5 mm
6.	Type	SMART type, 2 Wire, HART protocol, based on Time Domain Reflectometry
7.	Output	4-20 mA, DC
8.	Connection	Process Connection - SS 316L Flanged ANSI Electrical Connection - 1/2" NPT
9.	Enclosure Class	IP 66, Explosion proof
10.	Electrical Power	24 V DC
11.	Housing material	Die Cast Aluminum
12.	Local Display	LCD Display
13.	Accessories	Programming tool kit, gasket etc.

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21.0 DATA SHEETS – B (TO BE FILLED BY BIDDER)

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Data Sheet – B for Electronic Transmitter -Pressure, D.P., Flow, Level

S. No.	Features	Essential/Minimum Requirements
1.	Make	
2.	Model No.	
3.	Type of Transmitter	
4.	Accuracy	
5.	Output signal range	
6.	Turn down ratio	
7.	Zero and span drift	
8.	Load impedance	
9.	Stability	
10.	Housing	
11.	Over Pressure	
12.	Connection (Electrical)	
13.	Process connection	
14.	Adjustment/calibration/maintenance	
15.	Accessories	
16.	Diagnostics	
17.	Power supply	
18.	Repeatability	
19.	Hand held calibrator	

Data Sheet – B for Temperature Gauge

S. No.	Features	Essential/Minimum Requirement
1.	Make	
2.	Model No.	
3.	Sensing Element and material	
4.	Body material	
5.	Dial size	
6.	End connection	
7.	Accuracy	
8.	Scale	
9.	Range selection	
10.	Housing	
11.	Zero/span adjustment	
12.	Identification	
13.	Accessories	
14.	Material of Bourdon/ movement	
15.	Repeatability	
16.	Response Time	
17.	Over range Protection	
18.	Others	

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Data Sheet – B for Pressure and D.P. Gauges

S. No	Feature	Essential / Minimum Requirement
1.	Make	
2.	Model No.	
3.	Sensing Element	
4.	Material	
5.	End connection	
6.	Over range proof pressure	
7.	Repeat-ability	
8.	No. of contacts	
9.	Rating of contacts	
10.	Elect. Connection	
11.	Set point/ dead band adjustment	
12.	Enclosure	
13.	Accessories	
14.	Mounting	
15.	Switch Type	

Data sheet – B for Level Gauges

S. No	Features	Essential/Minimum Requirement
1.	Make	
2.	Model No.	
3.	Sensing Element and material	
4.	Body material	
5.	End connection	
6.	Accuracy	
7.	Scale	
8.	Range selection	
9.	Over range test	
10.	Housing	
11.	Identification	
12.	Visible Length	

Data Sheet – B for Control Valves

S. No.	Description	Requirement
1.	Make	
2.	Model No.	

S. No.	Service	Body material	Trim Material
1.	Non-corrosive, non-flashing and non-cavitations service		
2.	Severe flashing/cavitations services		
3.	Low flashing/cavitations service		

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S. No.	Service	Body material	Trim Material
4.	Condensate, DM water service		
	Features	Essential/Minimum Requirement	
5.	Fluid		
6.	Valve Size		
7.	Rating (ANSI)		
8.	Cv		
9.	Body	Type	
		Connection	
10.	Bonnet	Type	
		Packing	
		Lubricator	
11.	Trim	Plug	Type
		Cage	Type
		Guiding	
12.	Flow to Open/Close		
13.	Leakage Class		
14.	Opening at maximum flow		
15.	Opening at minimum flow		
16.	Overall Noise		
17.	Fluid outlet velocity		
18.	Codes & Standards		
19.	Actuator		
20.	Smart Positioner		
21.	I/P Converter		
22.	Other Accessories		
	Position Transmitter		
	Limit Switches		
	Solenoid Valve		
	Air Set		

Data Sheet – B for Indicators

S. No.	Features	Essential/minimum requirements	
		Digital indicator	Vertical indicator
1.	Make		
2.	Model No.		
3.	Type		
4.	Input signal		
5.	Display character		
6.	Accuracy		
7.	Response time		
8.	Signal Connection		

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S. No.	Features	Essential/minimum requirements	
		Digital indicator	Vertical indicator
9.	Power Connection		
10.	Zero/span adjustment.		
11.	Power supply		
12.	Power supply fuse connection		
13.	Mounting		
14.	Protection class		
15.	Identification		
16.	Dimension		

Data Sheet – B for C&I Cables

Conductor Size				
Parameter/ Type of Cable	Individual and overall shielded (Type F)	Overall Shielded (Type-G)	Individual and overall shielded Teflon Coated (Type I)	Extension cable (with/without Teflon coating) (Type A, B, C)
Mutual capacitance at 0.8 kHz (max.)				
Conductor Resistance (max.)				
Insulation resistance				
Cross-Talk figure at 0.8 kHz (min.)				
Characteristic impedance (max.)				
Attenuation at 1 kHz (max.)				

Data Sheet – B for Printers

S. No	Features	Color Laser Printer (A3)	Laser Printer (A4)	Color Inkjet Printer	Line Impact Dot Matrix Printer
1.	Make				
2.	Model No.				
3.	Paper Size				
4.	Printing Speed (min.)- in normal mode for A4 size paper				
5.	Type				
6.	Resolution (black) (min.)				
7.	First page out				

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S. No	Features	Color Laser Printer (A3)	Laser Printer (A4)	Color Inkjet Printer	Line Impact Dot Matrix Printer
	time (with full graphic display)				
8.	Paper input capacity (min.)				
9.	Additional features				
10.	Paper sheets (1 ream = 500 sheets) with each printer				
11.	Additional Cartridge/toner/ribbon of each type as used in printer with each printer				
12.	Communication ports				

Data Sheet – B for UPS

S. No.	Description	Units	Requirements
1.	Type		
2.	Power rating at load p.f 0.8 lagging		
	Application		
3.	Installation /paint shade		
4.	Input supply		
	Output Voltage		
5.	AC Voltage accuracy (steady state) over entire load PF & DC voltage range		
6.	Range of adjustment of AC output		
7.	AC harmonic content		
8.	Design Ref. Ambient	°C	
9.	Standby AC supply with isolation Transformer and servo controlled voltage stabilizer		
10.	Rating		
10.1	Type		
10.2	Ratio & frequency		
10.3	Automatic voltage regulator Percentage voltage regulation	% % %	
	<ul style="list-style-type: none"> • Transient response • Output voltage setting range 		
	Bypass transfer selection		
11.	Manual bypass PBs		
12.	Manual bypass switch		

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S. No.	Description	Units	Requirements
13.	Synchronizing between inverter and standby supply Static switch		
14.	Type		
15.	Maximum transfer time		

Data Sheet – B Ultrasonic Level Transmitter

S. No.	Features	Essential/minimum requirements
1.	Principle	
2.	Measuring Ranges	
3.	Signal Processing	
4.	Operating Freq.	
5.	Calibration & Configuration	
6.	Power supply	
7.	Signal Output	
8.	Hysteresis	
9.	Output contacts	
10.	Accuracy & Repeatability	
11.	Resolution	
12.	Operating temp.	
13.	MOC Sensor	
14.	Enclosure	
15.	Cable Connection	
16.	Display	
17.	Accessories like Cable gland, prefab cable, mounting accessories.	

Data Sheet – B Radar Level Transmitter

S. No.	Feature	Essential / Minimum Requirement
1.	Type	
2.	Application	
3.	Probe Type	
4.	Probe Material	
5.	Accuracy	
6.	Type	
7.	Output	
8.	Connection	
9.	Enclosure Class	
10.	Electrical Power	
11.	Housing material	
12.	Local Display	
13.	Accessories	

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22.0 ANNEXURE

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ANNEXURE – I: PLC / DCS SYSTEM (for area within R&M limit & existing C&I System) with HMI

S. No	Item name	Unit	Qty/Unit
1.	Control System		
1.1	Control system hardware with cabinets		On as required basis
1.2	Control Cabinets for housing Remote I/O hardware		On as required basis
1.3	Marshaling Cabinets and Termination cabinets		On as required basis
1.4	Relay panels to mount relays mentioned below:-		On as required basis
1.5	Interposing Relays		On as required basis
1.6	Cubicles for mounting network components & power supply distribution equipment.		On as required basis
2.	Human Machine Interface		
2.1	Operator Work Stations	Nos.	2
2.5	Operator cum engineering work station	Nos.	1
3.	Network Components		
3.3	Data Communication System		On as required basis
4.	Printers		
4.4	B/W Laser Printer (A3 size)	Nos.	1
5.	Software		
	Software for BMS meeting requirements specified under item "SYSTEM SOFTWARE REQUIREMENTS",		On as required basis

1. The quantities mentioned above are tentative/ indicative and minimum for BPSCL Boiler # 1.
2. The I/O count for the existing system beyond battery limit as given in **Annexure-2** shall also be included for design of the system.

Bidder shall design & supply the control & instrumentation equipments & systems to meet the intent of the specification and indicate the basis of design, bill of quantities in their offer.

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ANNEXURE – 2: SCOPE OF SUPPLY&ERECTION FOR EXISTING C&I SYSTEM (BEYOND BOUNDARY LIMIT OF R&M)

A. TRANSMITTERS: 50 nos. (PRESSURE & DP)

Table C

Sl. No.	Area	Nos.	Tag No.	Range	Secondary Range
I PRESSURE / VACUUM					
1.	Drum Pressure	3	PT 38	0 to 160 kg/cm ²	0 to 160 kg/cm ²
2.	Super-Heated Steam Pressure	3	PT 37	0 to 160 kg/cm ²	0 to 160 kg/cm ²
3.	Feed Water Pressure	3	PT 39	0 to 250 kg/cm ²	0 to 250 kg/cm ²
4.	Furnace Draft (L)	2	PT 87	(-)12.5 to (+)12.5 mmWC	(-)12.5 to (+)12.5 mmWC
5.	Furnace Draft (R)	2	PT 88	(-)12.5 to (+)12.5 mmWC	(-)12.5 to (+)12.5 mmWC
6.	BF Gas Pressure	2	PT 42	0 to 1000 mmWC	0 to 1000 mmWC
7.	CO Gas Pressure	2	PT 43	0 to 1000 mmWC	0 to 1000 mmWC
8.	Primary Air Pressure – A	1	PT 46	0 to 1000 mmWC	0 to 1000 mmWC
9.	Primary Air Pressure – B	1	PT 47	0 to 1000 mmWC	0 to 1000 mmWC
10.	Vacuum before Mill Fan – A	1	PT 62	0 to 1000 mmWC	0 to 1000 mmWC
11.	Vacuum before Mill Fan – B	1	PT 63	0 to 1000 mmWC	0 to 1000 mmWC
12.	Vacuum before Mill – A	1	PT 93	0 to 1000 mmWC	0 to 1000 mmWC
13.	Vacuum before Mill – B	1	PT 94	0 to 1000 mmWC	0 to 1000 mmWC
14.	Fuel Oil Pressure	1	PT 91	0 to 16 kg/cm ²	0 to 16 kg/cm ²
15.	Atomizing Steam Pressure	1	PT 36	0 to 25 kg/cm ²	0 to 25 kg/cm ²
II DIFFERENTIAL PRESSURE					
1.	Resistance across Mill – A	1	PT 65	0 to 250 mmWC	0 to 250 mmWC
2.	Resistance across Mill – B	1	PT 66	0 to 250 mmWC	0 to 250 mmWC
3.	Secondary Air Pressure Drop	1	PT 79	0 to 250 mmWC	0 to 250 mmWC
III LEVEL					
1.	Drum Level (L)	2	LT 129	520 to 0 mmWC	(-)315 to (+)315 mmWC
2.	Drum Level (R)	2	LT 130	520 to 0 mmWC	(-)315 to (+)315 mmWC

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Sl. No.	Area	Nos.	Tag No.	Range	Secondary Range
3.	Drum Level (Rec)	2	LT 103.1	520 to 0 mmWC	(-)315 to (+)315 mmWC
4.	Drum Level (Cont)	2	LT 103.2	520 to 0 mmWC	(-)315 to (+)315 mmWC
IV FLOW					
1.	CO Gas Flow	2	FT 101	0 to 63 mmWC	0 to 12,500 NM ³ /h
2.	BF Gas Flow	2	FT 102	0 to 100 mmWC	0 to 120,000 Nm ³ /h
3.	Steam Flow (Cont)	2	FT 95.1	0 to 1 kg/cm ²	0 to 250 t/h
4.	Feed Water Flow (Cont)	2	FT 97.1	0 to 6300 mmWC	0 to 250 t/h
5.	Injection Water Flow (L)	2	FT 98	0 to 1 kg/cm ²	0 to 5 t/h
6.	Injection Water Flow (R)	2	FT 99	0 to 1 kg/cm ²	0 to 5 t/h
7.	Super-Heated Steam Flow	2	FT 96	0 to 1 kg/cm ²	0 to 250 t/h
Total:		50			

B. SS SEAMLESS IMPULSE PIPE:

1000 MTR (1/2", SCH 160)
1000 MTR (3/4", SCH30)

Note:-Impulse piping shall be provided with related fitting like Elbows, TEEs and Sockets as per requirements.

C. ISOLATING VALVES:

CLASS 2500-60no., CLASS 1500-40 no., CLASS 300-50 no.(20mm size)

D. ELECTRICALACTUATOR: 30 Nos.

3PHASE, 50HZ, 230VAC OPERATED

APPLICATION : MODULATING TYPE
TRAVEL TIME : 45-55 SEC
POSITION FEEDBACK : 4-20 mA signal /Potentiometer
Motor Rating : 250 WATT
TORQUE (rating) : 2000 NM – 24nos., 4000NM – 6nos.
LIMIT SWITCHES : OPEN / CLOSE/TORQUE – 2nos. each
ENCLOSURE : IP 67

*The actuators shall be foot mounted with lever arm for connecting with damper link rod.

*The actuator should have adjustable mechanical stoppers on either side of lever.

E. TEMPERATURE ELEMENTS– Thermocouples – 40 nos.

TEMPERATURE ELEMENTS(COMPLETE SPECS WILL BE FINALISED DURING

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ENGINEERING)				
	AREA	QUANTITY	TYPE	DIMENSIONS
1	Feed Water Temperature	1 pts.	K-type T/C	6mm/6mtr MI
2	Temperature before Final SH (L)	2 pts.	K-type T/C	6mm/12MTR MI
3	Temperature before Final SH (R)	2 pts.	K-type T/C	6mm/12 MTR MI
4	Steam Temp before & after Injection (L&R)	4 pts.	K-type T/C	6mm/12 MTR MI
5	Drum Metal Temperature	6 pts.	K-type T/C	6mm/12 MTR MI
6	Screen Header	24 pts.	K-type T/C	6mm/12MTR MI

F. SUPPLY & LAYING OF CABLES

INSTRUMENT SIGNAL CABLE		Control Cable	
i.	12 PAIR ANALOG SIGNAL (0.5mm ²) : 1000 MTR	i.	4 x 2.5mm ² : 1000 mtr
ii.	8 PAIR ANALOG SIGNAL (0.5mm ²) : 1000 MTR	ii.	12 x 1.5mm ² : 1000 mtr
iii.	2 PAIR ANALOG SIGNAL (0.5mm ²) : 1000 MTR	iii.	7 x 1.5mm ² : 1500 mtr
iv.	8 PAIR BINARY SIGNAL(1mm ²) : 1500 MTR	iv.	24 x 1.5mm ² : 1000 mtr

NOTE: The above requirement is for interfacing of existing system field measurement, actuator operation console and electrical drive control with PLC / DCS. Any cabling requirement for additional electrical drives/MOVs shall be estimated and supplied by bidders.

G. I/O COUNT & INTERPOSING RELAYS FOR INTERFACING OF EXISTING SYSTEM WITH PLC / DCS

AI – 140	AO – 32
RTD – 40	T/C – 80
DI – 260	DO – 348
RELAYS	1 NO/NC PLC / DCS RELAY - 180(230V AC OPERATED) 2 NO/NC RELAY - 240(24 V DC OPERATED) 2 NO/NC RELAY - 80 (240V DC OPERATED)

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ANNEXURE – 3: TECHNICAL SPECIFICATION –PLC SYSTEM

- 1.0 Programmable Logic Controller (PLC) based control system shall be complete with a configuration of 1:1 hot redundancy having Central Processing Units (CPUs) of word length of 32 bits minimum, redundant communication processors, redundant memory modules, redundant power supply units, redundant data highway & link connecting Input/ Output modules and redundant data network connecting operator station.

Two CPUs shall operate on fault tolerant mode with continuous self and cross-monitoring facility. Failure of the active CPU shall not affect the operation of the plant. In the event of failure of active CPU, tasks shall be transferred to the standby CPU within fastest possible transfer time without causing any output to drop during the transfer period. In the event of both the CPU failure, the system shall revert to the fail-safe mode. The complete system of CPUs shall not be loaded over 60% of the individual capacity even under worst data loading conditions. It shall be possible to make a manual transfer from the active to the back-up CPU from engineering station and as well as from the front panel of CPU module. Module shall have adequate status and diagnostic indication on the front panel.

- 2.0 The system shall be of modular construction and expandable by adding hardware modules and incorporating them in the address register. Bidder shall provide at least 20% or minimum one number, whichever is higher, spare channels as hot-on-rail spares in each configured cards/modules. In addition to this 10% or minimum one number, whichever is higher, extra assigned complete spare modules mounted on rails in racks for each type of I/O modules shall also to be provided. The spare channel and cards shall be fully wired and terminated.

- 3.0 The memory unit of the CPU shall be field expandable. The memory capacity shall be sufficient for complete system operation and shall have the capability for future expansion at least to the tune of 25%. The application program/sequence logic etc. shall be stored in nonvolatile memory (EEPROM). However, all the dynamic memories shall be provided with battery backup with at least for 360 hours.

4.0 Input / Output system:

- a) Input / Output – The system should have the following types of I/O cards

- i) Analog Input : 4 – 20 mA
- ii) Analog Input : Three wire RTD
- iii) Analog Input : Thermocouple
- iv) Analog Output : 4 – 20 mA
- v) Digital Input : 24 V DC
- vi) Digital Output : 24 V DC

- b) Two types of inputs are not to be wired on the same module. The same module should not be used for I/P and O/P i.e. one particular module should cater either to I/P only or to O/P only. Different types of A/I (Thermocouple, RTD or 4-20 mA) should not be wired to the same module.

- c) I/O Modules to have following features:

- i) All I/O s isolation level form system electronics to the field should be 500 V or more.
- ii) DI / DO: No of channels per card to be more than 15 and less than 33.
- iii) AI/AO: No of channels per card to be more than 7 and less than 17.
- iv) I/O cards to be product of parent system manufacturer.
- v) Each I/O shall be protected against the reversal of the polarity of the power voltage to I/O.

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- vi) Each output shall be short circuit proof.
- vii) **PLC vendor should offer their latest system with latest series I/O cards. Controller and I/O cards should be from same series. Old generation cards and controller are not acceptable.**
- viii) The lower grade I/O cards like FLEX I/O's, Process I/O's, Plastic I/O's, remote I/O's etc. is not acceptable. Only high grade/ High end cards with advanced features of isolation and protection should be offered
- ix) Interrogation voltage shall be 24 V DC.

- 5.0 The data communication system of the PLC shall not be limited to the following:
- a) Bus and data network loading shall in no case be more than 60% of its capacity.
 - b) Redundant communication controller shall be provided for the purpose of communication between the I/O modules (including remote I/Os if any) and the PLC as well as in between PLC and the operators work stations.
 - c) The communication system design shall ensure that any single point failure on the system bus/media shall not disrupt not more than single message and disrupted message shall be automatically retransmitted.
 - d) Failure or physical removal of any station/modules connected on the system bus shall not lead to any loss of communication.
 - e) Diagnostics message on fault detection.
 - f) Bus change over from active bus to stand by bus, during failure of active bus shall be performed automatically and bumpless. Such event shall be suitably logged or alarmed.
 - g) Noise immune high-speed serial link optic fiber cable between CPUs and remote I/O modules with standard communication protocol shall be provided.
 - h) Main data network shall be noise immune high-speed communication link with bit rate in the range of 10 / 100 MB/sec and shall comply with the International Standard IEEE-802.3 (Ethernet) for data exchange and communication.
- 6.0 Communication for selected data transfer with PLC shall be either OPC or MODBUS protocol standard.
- 7.0 Operator work station shall be PC with latest configuration (IBM/DELL/HP make)and latest windows version operating system. one 24" and one 48" color TFT monitors, membrane KB, mouse, color laser printer and dot matrix printer shall be provided as peripherals. In addition to PC based operator cum engineering station, LAPTOP loaded with engineering software shall be furnished. For specification of operator / engineering station bidder shall refer to section-VI of this volume.
- 8.0 The MMI function PC based operator's station shall not be limited to the following:
- a) Selection of auto/Manual, open/close operation, sequence auto, start/stop operation etc.
 - b) Dynamic Mimic display depicting the entire process for control and monitoring purpose.
 - c) Alarm monitoring, report generation, logs, calculations and printing of logs, reports, trends etc.
 - d) Online / historical trending, historical storage and retrieval of data.
- 9.0 Annunciation System
- a) For PLC controlled area / plant, window based annunciation wherever required shall be an integral part of the PLC system. Sequence for annunciation shall be configured in PLC and shall conform to ISA sequence ISA-2A. Window lamps will be driven by PLC. For the systems where only monitor & keyboard based operator's station has been envisaged, alarm/ annunciation will be displayed in the operator's station.

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- b) The window lamps for the system shall be driven through output modules of the PLC. Each window shall have removable lamp box. The window shall have black lettering inscription on white background. However, for trip application red background shall be provided. Each of the annunciation windows shall be backlit with minimum two groups of clustered LED lamps. The window design shall be such that the lamp replacement can be done easily from the front.
 - c) Audible device shall be provided with the annunciation system. The devices shall have in built electronic tone generator with adjustable sound level and intensity controls.
- 10.0 Software
- a) All the necessary software for fulfilling the complete implementation of the control logics, operational displays & logs, data storage, retrieval and other functional requirements as indicated in this specification, shall be provided.
 - b) Licensed version of required software including operating system, configuration and MMI software shall be provided.
 - c) Programming language shall be user friendly. Detail documentation on the all programming software shall be furnished by the bidder and this shall be a part of the O&M manual.
- 11.0 Power Supply
- Power supply to the PLC system shall be provided from 2 X100% solid-state 230 V AC \pm 1% UPS (Uninterruptable Power Supply) system. For details UPS specification, please refer clause no. 7.
- 12.0 The system shall have high MTBF and shall be hot maintainable. The system hardware shall be designed to be "fault avoidant" by selecting high-grade components of proven quality and properly thermally de-rated design. The network shall have extensive fault monitoring, self-surveillance & on-line self-diagnostic capability so that failure up to module/card level is immediately detected. Each of the modules shall have its self-diagnostic system. The operator station located at the area control room shall be used for fault data presentation and monitoring purpose.
- 13.0 The system shall have capability to automatically check & correct gain & drift for ADCs on-line.
- 14.0 Data exchange in a bus shall be fully monitored and checked for validity.
- 15.0 Transfer of data from Remote I/O modules with PLC module shall be done through serial link as per standard protocol.
- 16.0 Input scan periods shall be equal to or less than:
- a) OLCS & sequence control inputs : 100 ms.
 - b) CLCS inputs : 250 ms.
 - c) Monitoring analog parameters : 500 ms.
 - d) Monitoring digital parameters : 250 ms.
- 17.0 Following operations will be performed on I/Os, as required:
- a) Square root extraction
 - b) Pressure & temperature compensation
 - c) Reasonability check of all inputs (analog specially), validate and quality tagging like good, bad, suspect etc.
 - d) Channel wise engineering unit conversion
 - e) Contact bounce filtering with adjustable time constant.

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- 18.0 All controllers shall be freely configurable with respect to requisite control algorithms. An extensive library of macros shall be included for the purpose. Adequate software capability shall be provided to implement closed loop control functions as follows:
- PID control and their variations.
 - On-off control
 - Cascade control
 - Ratio and bias control
- 19.0 Features for Open Loop Control shall not be limited to following:
- Logic functions like AND/OR/NOT gates, timers (on-delay, off-delay), shift registers, counters, latches, flip-flops, mono-shots etc.
 - The automatic sequence control to ensure sequential start up and shutdown of auxiliaries/equipment. Sequence control shall be performed in groups initiated by command from operator's console. A sequence shall be made of steps executed in predetermined order according to logic criteria. For each step there shall be a provision for 'waiting time' and 'monitoring time', and it shall output an action on the process. System shall have the capability to bypass a step if desired by the operating personnel from the operator's station. Such action however shall be registered as an exception or alarm.
 - Increase the reliability and availability of the plant as a whole, for example, by timely and correct switchover to standby drives etc.
 - Basic interlock and protection logic related to safety of individual drive and plant equipment. All inputs required for protection system shall be on high priority basis. In the event of either loss of control power or control signal input to the drive, the drive shall remain in its last position unless specifically required otherwise. The system shall be designed such that no upset occurs either to process or to the drive when the power is restored.
- 20.0 Interface of the system with M.C.C/Switchgears shall be in the form of potential free contacts via interposing relay modules mounted in the respective switchgear or MCC unit. All other interfacing relays shall be mounted in a separate cabinet or a separate section of the cabinet. 10% additional interposing relay modules shall be provided as installed spare. Freewheeling diodes shall be provided across the coil of DC solenoid and contactors/relays. For AC solenoids and contactors directly driven from output cards, arc suppressors shall be provided across the coil. All field terminals (DI/DO) are to be provided with fuses and shall have fuse blown indication.
- 21.0 The operator's station shall be responsible for handling all commands as well as in generating desired displays and print outs.
- 22.0 Programming shall be with an easily understandable high-level language. Preferably with FBD. Programming shall also be permissible by drawing Ladder or Boolean Diagram. Single programming instruction/command shall be sufficient to delete a program rung from memory. Similarly, any rung can be inserted into the existing program. The active and the stand-by CPU programs shall equalize automatically, once the new program is permitted to 'RUN'.
- 23.0 Updating time and reaction time (system's response to an operator's command) for operator stations shall be as follows:
- Calling up a mimic : 2 sec or better
 - Updating status signal in mimic : 1 sec or better
 - Updating variables in a mimic : 1 sec. or better
 - Issuance of command to output : 1 sec. or better
- (without considering travel time and process lag)

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24.0 Programmable Controller shall be responsible for real time process parameter monitoring, storage & display. Basic requirements are (i) Operator Interface, (ii) Basic Calculation, (iii) Alarm Monitoring with display & audio & Reporting, (iv) Display generation, (v) Logs, (vi) Trend Recording & (vii) Historical Storage & Retrieval.

25.0 The displays at the operator console shall be classified into overview display, group display, point display and trend display.

- a) Overview display - This display is to enable the operator to set an overview of the entire plant section.
- b) Group display - The group display page shall display several sub-sections & present status information.
- c) Point display - Along with the specified parameter value, this page should indicate historical trend of the parameter.
- d) Trend display - This display include real time/historical trend display facility including Dynamic Graphic Display & Bar Graph Display.
- e) Alarm Message Display - It shall be possible to display process as well as system alarms for operator's attention and action. Alarm shall appear immediately on the operator station as and when they occur on priority basis. In addition to alarms appearing on different displays, the system shall also be able to display alarm summary and alarm history listing the date and time of occurrence, tag number, point description, type of alarm (absolute value or deviation), serial number of alarm in the sequence of occurrence etc. Alarm shall disappear from display only when they are acknowledged and cleared. Abnormal condition in the system shall be displayed as system alarm message on the operator console irrespective of display selected. In all cases occurrence of an alarm shall be logged.

26.0 Logs shall not be limited to the followings. The printing of these logs shall be initiated automatically at prescribed time intervals, or initiated on demand by the occurrence of predefined events.

- a) Shift/Daily Log
A shift/daily log shall be provided to furnish data for routine analysis of plant performance. This log shall be automatically printed at specified time each day and on demand at any time.
- b) Summary Log (On Demand)
The system shall permit the operator to specify minimum of 5 summary logs each with minimum of 25 points to be printed on demand.

27.0 The salient hardware/ software features of the PLC system for I/O handling shall be as follows.

- a) Input filters to attenuate noise.
- b) SWC of 500V DC common mode and 500V AC peak to peak
- c) Comm. Mode Noise rejection for analog inputs of 120 db at 50 Hz.
- d) Normal mode noise rejection for analog inputs of 60 db at 50 Hz.
- e) LED indicators on each card to show status of input.
- f) All the outputs shall be with individual fuse.
- g) J/K type thermocouple mV input where applicable.
- h) Pt-100 three / four wire resistance thermometer input where applicable.
- i) 24 V DC power supply to field mounted two wires transmitters.

28.0 The salient hardware/ software features of the CPUs as follows:

1. Watch dog timer : Periodical reset. Alarm and interruption, if not reset within stipulated time.

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2. Max. scan time for I/Ps : 1 sec. max.
3. Maximum Scan Rate : 1 ms (Per K Word) or better
4. Memory capacity : 25% spare capacity after full utilization. Expandable in multiples of 16 K.
5. Comm. processor : Integral / Separate
6. Battery backup for RAM : Ni-Cd / lithium type, at least for 360 hrs continuous operations during power failure.
7. Diagnostic feature : Periodic, automatic self- diagnostic. Result available at the Operator's station.

29.0 The salient features of the Input / Output modules are as follows.

- a) All modules
 1. Ambient temp. : 0-50° C
 2. Surge withstand capability : IEC-255.4
- b) Digital General
 1. No. of channels / module : 16
 2. Interrogation voltage : 24V DC or 48 V DC
 3. Status indicator : LED type.
 4. Isolation : Optical
- c) Digital Input Module
 1. Contact bounce filtering : Adjustable time constant of 15 m. sec.
 2. Diagnostic : Module fault, wire break
- d) Digital Output Module
 1. Output protection : Individual fuse
 2. Diagnostic : Module fault
- e) Analog General
 1. No. of channels / module : 8
 2. Isolation : Galvanic/Optical
- f) Hi-level Analog Input Module
 1. Type of input : 4-20 mA DC / 1-5V DC
 2. A/D Converter : 16 bits + Sign (or better)
 3. Accuracy : 0.1% or better
 4. Diagnostic : Module fault
 5. Powering of transmitter : 24 V DC 2 W type
- g) Low Level Analog Input Module
 1. Type of input : PT-100; T/C(As required)
 2. C-J-C : On Module
 3. Accuracy : 0.1% or better
 4. A/D converter : 16 bits + Sign (or better)
 5. Diagnostic : Module fault
- h) Analog Output Module
 1. Type of output : 4-20 mA DC
 2. Accuracy : + 0.1% or better
 3. Load : 600 OHM
 4. Diagnostic : Module fault

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ANNEXURE – 4: TECHNICAL SPECIFICATION – DDCMIS SYSTEM

1.0 SPECIFICATION OF THE DCS SYSTEM:

- 1.1 The DDCMIS (DCS) should comprise the functionality of Distributed Digital Control (DDC) and Data Acquisition System (DAS) and shall be designed based on Open Architecture Concept/ Configuration.
- 1.2 The job involves design engineering, supply and commissioning of new system along with dismantling of old panels and transporting them to a safe storage within battery limits of BPSCL.
- 1.3 This is a retrofitting job. Floor space available is a constraint. The requirement of floor space for system panels should be clearly spelled out.
- 1.4 There should not be any module / unit / component etc. failure of which along with its failure of its redundant unit will result in stoppages of all HMI's and controller in the network.

If Server Client Architecture is offered then each Operator Station shall have its own Operation, Monitoring and Controlling Software installed in the Operators PC. These Operators shall be capable of Storing data along with real time access. Only real time access stations will not be acceptable.

- 1.5 The offered system should be OPC compliant and all necessary hardware and software for OPC server and OPC client should be included so that the system can send and receive data, graphics, history and control commands etc. to and from other OPC compliant systems. This should not require any additional software or drivers etc. at either side.
- 1.6 The offered software should have sufficient capacity in terms of tags, I/O handling capacity, open and closed loop control handling etc.
- 1.7 The system envisaged will have control stations with redundant controllers as per the system requirement, 02 operating stations (with one 24" and one 48" monitors), 01 no. Engineering station. Online programming, program storing, fault diagnostics shall be available on the workstation. . Engineering station HMI shall consist of color high resolution 24"size TFT screen of continuous duty, Industrial PC (Pentium PC with latest configuration of reputed make like IBM, COMPAQ,HP,DELL etc.) ASCII keyboard, mouse and printers . The workstation shall use 220 V AC UPS power.
- 1.8 Online / offline logic diagrams along with data are to be displayed through ladder diagram or functional flow charts or SFC.
- 1.9 Data Highway speed network /bus connecting HMI's, Controllers and Engineering Stations should be 10/100 MBPS or more. The data exchange rate between redundant Processors shall not be less than 10 MBPS. The communication speed between I/O racks and the controllers should not be less than 1 MBPS.
- 1.10 Operating system should be based on latest windows operating system.
- 1.11 Redundancy at all stages i.e. Controllers, Power supplies, Communication, System BUS, I/O BUS and I/O interfacing modules in I/O racks to be provided through dual modules and not through two ports in same module.

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- 1.12 **HMI shall be of standard industrial PC with latest Pentium processor.**
- 1.13 The system should provide two independent MODBUS ports for communication to other systems.
- 1.14 The close loop control shall have output facility of PID modules pulse train to operate ELECTRICAL ACTUATOR as well as PID modulated analog signal (4 -20 mA) to operate pneumatic actuator.
- 1.15 **The PID control loops for electrical actuators have to be efficiently and effectively implemented.**
- 1.16 **Sequence of event recording system with 100 inputs shall be offered with 1 ms resolution & 1 ms time stamping.**
- 1.17 **The tenderer shall offer only the latest model of their DCS to take care of the obsolescence of technology. Tenderer shall also confirm that its spare available in market for next 15 years.**
- 1.18 **GLOBAL DATABASE:**
 - a) Any creation/change of new or old database (i.e. tags) in the database of a controller should reflect immediately in all HMI's and controllers of the system without any modification or creation or alteration of software elsewhere.
 - b) Each tag and database is to be identified with unique name throughout the system and cannot be duplicated in original form.
 - c) No two tags can co-exist with same name either in controllers or HMI's connected to the total network.
- 1.19 **Monitoring/Controlling of all Parameters/Drives/Actuators should be possible from any HMI. However enabling/disabling of monitoring/controlling of parameters / Drives/Actuators should also be possible.**
- 1.20 **Suppliers shall submit the list of installation where the offered system has been successfully commissioned and are working efficiently in a power plant. Certificate of performance indicating to be submitted.**
- 1.21 **The system shall allow ONLINE configuration and modification. The system should have the capability to simulate TEST the TAGS, SEQUENTIAL LOGIC AND THE CONTROL LOOPS before putting it into the running system.**
- 1.22 Operation of the DCS shall be completely unaffected by a momentary loss of power of the order of 20m sec.
- 1.23 The entire DCS network system shall have an extensive set of self-diagnostics routines at all levels which shall locate and identify the system failure at least up to modules / card level through HMI displays and report **print outs**.
- 1.24 The functional block diagram for logic shall be indicated during detailed engineering and in general be implemented on one to one basis for existing system. However, purchaser reserves the right to revise the logic diagrams during detailed engineering even during commissioning.
- 1.25 **Vendor shall consider supply 10% spare channels in each card and 10% additional I/O cards of each variety mounted in the I/O rack.**

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1.26 **Vendor should be prepared with all sorts of commissioning spares for completion of the job in all respect.**

1.27 **Card Replacement:** Plug 'n' run type. On line replacement of modules shall be possible without affecting the system operation.

2.0 PROCESSOR SYSTEM:

2.1 Processor shall be 32 Bit or above.

2.2 Each process control station is duplex in nature for control application, comprising of a pair of controller in REDUNDANT HOT STANDBY mode. Each control station is organized with controllers and I/O cards. Redundant CPU's, power supply, communication modules will be preferably mounted on a single rack to facilitate very high-speed data exchange between two CPUs (independent of network speed) through back plane.

2.3 In case redundant CPU's are mounted on separate racks, redundant optical fiber cable will be connecting both CPU racks to facilitate data transfer at a very high speed independent of the NETWORK.

2.4 The system will execute all control function with the help of set of pre-programmed functions resident in the controller. Necessary Software is to be provided for Auto tuning facility. Loop test/ Simulation Software to be provided for both control as well as Logic Program, for testing and simulating any loops in the system offline.

2.5 Memory shall be non-volatile. However in case volatile memory provided; battery back-up shall be provided to keep the program storage intact. A battery drain indication shall be provided.

2.6 Watchdog timer shall be a software device. The healthiness of the processor shall be continuously monitored by watchdog timer. Any hardware or software problem in the processor system, which shall include, CPU, Memory, power supply, communication interface etc. shall cause the watch- dog timer to report processor failure.

2.7 The redundancy shall be provided in such a way that in case of failure the main processor, the hot standby shall take over automatically without any interruption to the process. The change over shall be bump less. Redundancy shall be provided for complete processor system including CPU, Memory, and power supply.

2.8 On power failure, failsafe and graceful shutdown shall take place without any loss of data. Restart shall be automatic with provision for manual operation also.

2.9 The close loop control shall have output facility of PID modules pulse train to Operate ELECTRICAL ACTUATOR as well as PID modulated analog signal (4 – 20 mA) to operate pneumatic actuator.

3.0 Input / Output System:

3.1 Input / Output -- The system should have the following types of I/O cards

- a) Analog Input : 4 – 20 mA
- b) Analog Input : Three wire RTD
- c) Analog Input : Thermocouple
- d) Analog Output : 4 – 20 mA

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- e) Digital Input : 24 V DC
- f) Digital Output : 24 V DC

3.2 Two types of inputs are not to be wired on the same module. The same module should not be used for both I/P and O/P i.e. one particular module should cater either to I/P only or to O/P only. Different types of A/I (Thermocouple, RTD or 4-20 mA) should not be wired to the same module.

3.3 I/O Modules to have following features:

- a) All I/O s isolation level form system electronics to the field should be 500 V or more.
- b) DI / DO: No of channels per card to be more than 15 and less than 33.
- c) AI/AO: No of channels per card to be more than 7 and less than 17.
- d) I/O cards to be product of parent system manufacturer.
- e) Each I/O shall be protected against the reversal of the polarity of the power voltage to I/O.
- f) Each output shall be short circuit proof.
- g) DCS vendor should offer their latest system with latest series I/O cards. Controller and I/O cards should be from same series. Old generation cards and controller are not acceptable.
- h) The lower grade I/O cards like FLEX I/O's, Process I/O's, Plastic I/O's, remote I/O's etc. is not acceptable. Only high grade/ High end cards with advanced features of isolation and protection should be offered
- i) Interrogation voltage shall be 24 V DC.

4.0 DCS OPERATING CUM ENGINEERING STATION:

4.1 Engineer interface system shall be primarily an engineer's interface which shall normally be used for configuring, tuning and maintenance of the Distributed Control System.

Engineering console shall have as a minimum the same capability as operator console. However the operation of the plant shall be restricted from this console only in tuning mode. All the plant views as specified under operator console shall also be available on Engineering console.

It shall be possible to perform all system configuration functions from the Engineering console typically.

- a) Data base configuration including overview, group, loop, multi loop and multi-variable control configuration.
- b) Group or multi-group alarm inhibit from the plant under maintenance.
- c) Configuration or re-configuration of alarm settings, their values, addition or deletion of any control block or components in a loop.
- d) Tuning of control loops like changing, PID, dead time values
- e) Compilation of graphic displays
- f) Setting of real time clock
- g) Compilation of logs/reports/historical trend points.
- h) To call detailed self-diagnostic displays for maintenance aid.

Tuning of a control loop shall be possible from engineering as well as from operator console, the location shall be selected by the operator using a "Tuning mode" key-lock switch provided on the operator console. In tuning mode it shall be possible to operate only the loop under tuning from engineering console. In case of simultaneous commands from operator and engineering consoles, operator console shall over-ride.

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During the normal operation, the engineering console, in no case shall interfere with the process operation or system software. However, any change in the configuration shall be down loaded into the system with proper knowledge of the operator.

- 4.2 The screen should update within 2 sec or less under worst conditions of system loading, irrespective of dynamic points, number of objects or graphics complexity.
- 4.3 During normal operation of DCS, the Engineering Station shall be kept switched off and system operation shall not be affected due to this. Engineering Station shall be made operative as and when required for engineering maintenance work.

5.0 SYSTEM SOFTWARE:

- 5.1 HMI software (which shall be Windows based) or equivalent for generation of the dynamic graphics, Bar graph displays, Trends, Mimics, display for PID loop tuning (PV, SV, MV,P, I,D etc.), report generation shall be offered. History logging shall be provided. Necessary Software is to be provided to have Auto tuning facility. Loop Test / Simulation Software are to be provided for both control as well as Logic Program for testing and simulation of any loops in the system offline.
- 5.2 Provision for following algorithms shall be available but shall not be restricted only to (Linearization, Cold Junction Compensation, Square root extraction, integration of binary inputs, lead /lag compensation, PID Control for electrical actuators, feed forward, ratio, adaptive, cascade control etc.). All the above algorithms shall be modular structure and shall be configurable from the console.
- 5.3 Close loop control shall have output facility of PID modules pulse train to operate ELECTRICAL ACTUATOR as well as PID modulated analog signal (4 -20 mA) to operate pneumatic actuator.
- 5.4 The implementation of control loops should be based on function blocks features shall include 3 - ELEMENT CONTROL, CASCADE CONTROL, RATIO CONTROL, FEED FORWARD & OVER-RIDE control.
- 5.5 ADAPTIVE / SELF TUNING facility of PID blocks must be available.
- 5.6 Individual licensed soft copy of all loaded software for all HMI's, Engineering Stations and controllers, etc., are to be given to Purchaser.

ANNEXURE – 5: SUB VENDOR LIST

The following list indicates the supplier generally considered for supply of major equipments/systems. However contractor can offer alternate makes with prior approval. Purchaser has the right to add/delete any vendor from the list during kickoff meeting.

LIST OF SUB VENDORS FOR INSTRUMENTATION				
1.	PLC	Rockwell Automation, SIEMENS, ABB		
2.	DCS	Yokogawa, Honeywell, Emerson, ABB, maxDNA/METSO DNA		
3.	Pressure Gauges	DH-Budenberg Instrumentation Pvt. Ltd. Forbes Marshall Pvt. Ltd. General Instrument Consortium, Mumbai Ifm Electronic India Private Limited Micro Process Controls		
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		Precision Industries Standard Instrument Waaree Instruments Ltd., Mumbai Wika Instruments India Pvt. Ltd., Kolkata Yantrika Instruments Pvt. Ltd., New Delhi
4.	Temperature Gauges	ASHCROFT Detriv Instrumentation & Electronics Ltd. Forbes Marshall Pvt. Ltd. General Instrument Consortium, Mumbai Industrial Instrumentation Manometer India Micro Process Controls Standard Instrument Waaree Wika Instruments India Pvt. Ltd., Kolkata
5.	Pressure Switches	Indfos General Instrument Consortium, Mumbai Switzer Waree Ifm Electronic India Private Limited Honeywell Automation India Pvt. Ltd. Hydac Wika Instruments India Pvt. Ltd., kolkata
6.	Thermocouples / RTDs	Detriv Instrumentation & Electronics Ltd. Endress + Hauser (India) Pvt. Ltd. General Instrument Consortium, Mumbai Honeywell Automation India Ltd. Nagman Instruments & Electronics (P) Ltd. Pyro Electric Instruments Tempsens Instrument India Pvt. Ltd. Toshniwal Industries Pvt. Ltd., Kolkata Unicontrols Instruments Pvt. Ltd., Kolkata Waaree Instruments Ltd., Kolkata
7.	Smart Transmitter (P, L, F, DP)	ABB India Limited Emerson Process Management Endress + Hauser (India) Pvt. Ltd. Fuji Electric India Pvt. Limited Honetwell Automation India Pvt. Ltd. SIEMENS Ltd. Yokogawa India Ltd.
8.	Mass Flow Meter	Emerson, E&H, Yokogawa, ABB, Honeywell
9.	Control Valves	ILP, Fisher Sanmar, MIL, CCI, Dresser, Masonelin
10.	I/P Converters	ABB BELLS Emerson Process Management (I) Pvt. Ltd., Kolkata Fair Child Forbes Marshall Pvt. Ltd. Honeywell Marsh Bellofram SIEMENS Yokogawa India Ltd.
11.	Flow Elements	Microprecision, IL-Palghat, Emerson, GIC
12.	Solenoid Valves	Asco, Rotex, SMC Pneumatic

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PROJECT NO.: ETRM012	PROJECT NAME: Boiler # 1 (220 TPH)	PACKAGE / SYSTEM: STEAM GENERATOR & AUXILIARIES (C&I)
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13.	Instrument Cables	Finolex, Delton, Belden, Universal, Torrent, Paramount, GIC, Polycab, KEI
14.	Uninterruptible power Supply	Eaton Power APLAB D. B. Power Electronics Ltd., Kolkata Emerson Power Hi-Rel Electronics Pvt. Ltd., Kolkata Numeric Power Systems Ltd., Kolkata Schneider Electric
15.	Battery for UPS	AmaraRaja, HBLNIFE, EXIDE
16.	Control Panels / Desk	Rittal, Pyrotech, ILK
17.	Transducers	SIEMENS, ABB, Meco, Automatic Electric, Honeywell, GE Sensing Ltd.
18.	Electrical panel Meter (Ammeter, Voltmeter)	Automatic Electric, Meco, ABB
19.	Selector Switches & Control Switches	Kaycee, SIEMENS, ALSTOM, L&T, Schneider, ABB, GE
20.	Terminal Blocks	Phoenix, WAGO, Elemax, Wiedmuller
21.	AC to DC Converter	Phoenix, SIEMENS, Cosel
22.	Erection Hardware, Impulse Tubing & Piping, Fittings	Microprecision, Wesmec Engg., Met Press, SMC Pneumatic, Flowtech, Aastec, Swaglok
23.	Flow Meters	ABB, E&H, Krohne, Yokogawa, Honeywell, Emerson, GE Sensing
24.	Power Cylinders / Actuators	ILP, Keltron, FESTO, Rotex
25.	Air Filter Regulator	Emerson Process Festo India Private Limited Rotex Automation Schrader Schovill Shavo Norgren SMC Pneumatics Youngtech
26.	Electric Actuator	AUMA, Bernard, IL-Pallakad, Rotork