NTPC Limited

(A Government of India Enterprise)

EPC PACKAGE FOR SETTING UP 700 TPD (2 X 350 TPD) WASTE TO ENERGY PROJECT AT KAWAS, SURAT

TECHNICAL SPECIFICATION

FOR

EPC PACKAGE

PART – B (CONTROL & INSTRUMENTATION)

(BOOK 3 OF 5)

SECTION - VI

BIDDING DOCUMENT NO.: CS-2600-001-9

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PART – B

CONTROL & INSTRUMENTATION

PART – B (CONTROL AND INSTRUMENTATION SYSTEM)		
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BASIC DESIGN CRITERIA

CLAUSE NO.	TECHNICAL REQUIREMENTS
	BASIC DESIGN CRITERIA
1.00.00	**GENERAL REQUIREMENTS**
1.01.00	The Contractor shall provide Independent Control & Instrumentation system consisting of Distributed Digital Control, Monitoring and Information System (DDCMIS), Other Automation Systems like PLC etc., associated Measuring Instruments, Process Connection and Piping, Electrical Power Supply System, Maintenance and Calibration equipment, Public Address system (PAS), Steam and Water Analysis System (SWAS), Control Desk (CD), Close Circuit Television System (CCTV), associated Instrumentation and Power Supply Cables, Control valves and Actuators etc. as identified in the specification.
1.02.00	In addition to requirements specified under this Section-VI, Part-B, all C&I systems/ sub-systems/ equipment/ devices shall also meet other requirements stipulated under other Sub-sections/ parts/ sections of specification.
2.00.00	**PROVENNESS CRITERIA**
2.01.00	Bidder shall either provide his own DDCMIS or from his approved suppliers meeting all provenness, parametric, technical and other requirement specified under various sections of this specification.
2.02.00	All equipment, systems and accessories furnished under this specification shall be from the latest proven product range of a reputed experienced manufacturer whose successful performance has been established by a considerable record of satisfactory operation in Waste utility power station as specified in Section IFB and/or Section-VI. Bidder shall furnish satisfactory evidence regarding successful operation and high reliability of the proposed equipment/systems in coal fired utility stations for similar applications for meeting this requirement as specified in Section IFB and/or Section-VI.
2.03.00	The Bidder shall furnish a complete list of bought out items (i.e., items not from manufacturing range) which the Bidder has included in his proposal along with the names of proposed suppliers as a part of his proposal. However the make and model of all bought out items to be supplied by the Contractor shall be as approved by Employer during detailed engineering stage.
3.00.00	**RELIABILITY AND AVAILABILITY**
3.01.00	Each component and system offered by the Bidder shall be of established reliability. The minimum target reliability of each piece of equipment like each electronic module/card, Power supply, Peripheral etc. shall be established by the Bidder, considering its failure rate/mean time between failures (MTBF), meantime to repair (MTTR), such that the availability of the complete DDCMIS is assured for 99.7%.
3.02.00	When more than one device uses the same measurement or control signal, the transmitter and other components/ module shall be fully equipped to provide all signal requirements. All the 4-20 mA output signals from transmitters/other control system shall be able to drive minimum 500 Ohms load resistance. The system shall be arranged so that the failure of any monitoring device or control components or spurious intermediate grounding in the signal path shall not open the signal loop nor cause the loss or malfunction of signal to other devices using the same signal.
3.03.00	To ensure availability, adequate redundancy in system design shall be provided at hardware, software and sensor level to satisfy the availability criterion mentioned above. For the protection system, independent sensing devices shall be provided to ensure adequate safety

of plant equipment. For Turbine protection system , Turbine Bypass system, sensing device as per Manufacturer's standard and proven practice shall be provided.

4.00.00 STANDARDISATION AND UNIFORMITY OF HARDWARE

4.01.00 Bidder shall ensure that various C&I instruments /equipment like vibration monitoring system, 4-20mA electronic transmitters / transducers, Temperature elements and other instruments/ local devices etc. that are being furnished by the Bidder, are of the same make, series and family of hardware to the extent possible so as to ensure smooth and optimal maintenance, easy interchangeability and efficient spare parts management.*For the instruments that are proposed to be connected to Bidder's Steam Turbine Generator integral controls and other Skid Mounted instruments, Bidder's standard and proven instruments are acceptable.*

4.02.00 **Bidder to ensure that the depth of all the cabinets (both DDCMIS and Non-DDCMIS) shall be 800mm except in few cases like Gram Feeder Cabinets, Power Supply Cabinets.**

5.00.00 OPERABILITY & MAINTAINABILITY

5.01.00 The design of the control systems and related equipment shall adhere to the principle of 'Fail Safe' Operation wherever safety of personnel / plant equipment is involved. 'Fail Safe' operation signifies that the loss of signal, loss of excitation or failure of any component shall not cause a hazardous condition. However, it shall also be ensured that occurrence of false trips are avoided / minimized.

5.02.00 The types of failure that shall be taken into account for ensuring operability of the plant shall include but not be limited to:

—	Failure of sensor or transmitter.
—	Failure of main and/or redundant controller/other modules.
—	Loss of motive power to final control element.
—	Loss of control power.
—	Loss of instrument air.

5.03.00 The choice of hardware shall also take into account sound maintainability principles and techniques. The same shall include but shall not be limited to the following:

—	Standardization of parts.
—	Minimum use of special tools.
—	Grouping of functions.
—	Interchangeability.
—	Malfunction identification facility/self-surveillance facility.
—	Easy modular replacement.
—	Fool proof design providing proper identification and other features to preclude improper mounting and installation.

—	Appropriate de-rating of electronic components and parts.

5.04.00 The equipment shall employ latest state of the art technology to guard against obsolescence. In any case, Contractorshall be required to ensure supply of spare partsin line with relevant clause of GCC for spares. In case, the Bidder feels that certain equipment/component *(barring HMI hardware and networking components)* 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. For HMI hardware and networking components, *Bidder need not bring out the same in the bid; but shall inform the Employer in case of obsolesce so that Employer can take appropriate actions as necessary (both during the tenure and outside the tenure of the contract).*

6.00.00 CONTROL & MONITORING PHILOSOPHY

6.01.00 Control & Monitoring philosophy to be adopted for this project irrespective of the scope of supply (i.e. under this package or in any of Employer's other Packages) is explained in subsection-IIIC Part –A of specification .

6.02.00 Back-Up Instrumentation

As per Employer's practice, certain back-up instrumentation and Secondary instruments are to be provided. The exact quantity of the back-up instrumentation shall be as finalized during detailed engineering in consultation with the Contractor.

7.00.00 ENVIRONMENTAL CONDITIONS

7.01.00 Instruments, devices and equipment for location in outdoors/indoor/air-conditioned areas shall be designed to suit the environmental conditions indicated below and shall be suitable for continuous operation in the operating environment of a Waste utility station and also during periods of air conditioning failure without any loss of function, or departure from the specification requirements covered under this specification.

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

CLAUSE NO.	TECHNICAL REQUIREMENTS

Air Conditioned Areas

24 +/- 5 degree C normal/50 degree C max.*	Atmosphere	90% Max. / 10%min.	Air	IP 22***

* During air conditioning failure for a short period of time.

**For non-ventilated equipment/ control system enclosures. For ventilated equipment/ control system enclosures, protection class shall be IP 42.

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

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

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

For the remote I/O cabinets mounted in non-AC areas, panel AC shall be provided.

8 . **GROUNDING SYSTEM**

All panels, desks, cabinets shall be provided with a continuous bare copper(or chromated steel for DDCMIS panels, as per OEM Standard practice)ground bus. The ground bus shall be bolted to the panel structure on bottom on both sides. The bolts shall face inside of panels.

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

Shield on instrumentation cables shall be grounded on panel side. Suitable shielding terminals shall be furnished on Copper flat forming system ground.

Alternatively, Manufacturer's standard & proven solution, which is functionally equivalent shall also be acceptable subject to employer's approval.

The Biddershall submit with the offer recommended grounding scheme required for his system. The exact grounding scheme shall be finalized during detailed engineering.

SUB–SECTION – IIIC - 02

DISTRIBUTED DIGITAL CONTROL, MONITORING & INFORMATON SYSTEM (DDCMIS)

1.00.00	**DISTRIBUTED DIGITAL CONTROL, MONITORING AND INFORMATION SYSTEM (DDCMIS)**
1.01.00	**General Requirements**
1.01.01	The requirements for Distributed Digital Control Monitoring and Information System (DDCMIS) are indicated on functional basis in this specification. Contractor shall be responsible for engineering, selection and connection of all components and sub-systems to form a complete system whose performance is in accordance with functional, hardware, parametric and other requirements of this specifications. It is not the intent or purpose of this specification to specify all individual system components since the Contractor has full responsibility for engineering and furnishing of a complete system.
1.02.00	**System Configuration**
	DDCMIS shall basically consist of the following: ----
1.02.01	Control System (including its Measurement system).
1.02.02	Human-Machine Interface and Plant Information System (HMIPIS)
1.02.03	System Programming & Documentation Facility
1.02.04	Data Communication System
1.02.05	Integrated LVS based Annunciation functions
1.02.06	Time synchronization with Master clock
	The basic configuration of DDCMIS shall be as indicated in the DDCMIS configuration drawing No. 0000-999-POI-A-001.
	Contract Quantities of the C&I System shall be as per Part-A.
1.03.00	**System Expandability**
1.03.01	Modular System design shall be adopted to facilitate easy system expansion. The system shall have the capability and facility for expansion through the addition of controller modules, I/O cards, peripherals like Large Video Screen (LVS), operator workstations (OWS), printers etc., while the existing system is fully operational. The system shall have the capability to add any new control loops, groups/subgroups in control system, while the existing system is fully operational.
1.04.00	**On-Line Maintenance**
1.04.01	It shall be possible to remove/replace various modules online (like I/O module, interface module etc.) from its slot for maintenance purpose without switching off power supply to the corresponding rack. System design shall ensure that while doing so, undefined signaling and releases do not occur and controller operation in any way is not affected. Further, it shall also be possible to remove/replace any of the redundant controller module without switching off the power to the corresponding rack and this will not result in system disturbance or loss of any controller functions for the other controller. The on-line removal/insertion of controller, I/O modules etc. shall in no way jeopardize safety of plant and personnel.

1.05.00 **Fault Diagnostics**

1.05.01 The DDCMIS shall include on-line self-surveillance, monitoring and diagnostic facility so that a failure/malfunction can be diagnosed automatically and reported/indicated remotely on OWS/LVS/Programmer station. The failure/ malfunctions to be reported shall include:

(a) Module level faults of control system.

(b) Failure of HMIPIS bus/unit LAN, system bus, Local/Remote comm. Bus.

(c) Power supply faults (Over voltage, under voltage, loss of input) for each feeder of power supply for system / marshalling/ relay and HMIPIS cabinets.

(d) Software faults.

These faults shall typically be reported as color change on system status display and messages on programmer station/ LVS/ OWS as well as through local indication. The diagnostic system shall ensure that the faults are detected before any significant change in any controller output has taken place. Failure of any I/O modules, Controller etc. shall be annunciated to LVS/OWS. For I/O modules, these alarms shall be grouped, while for controller, comm. controller, power supply, these shall be individual. In case the faults are not acknowledged / rectified within certain interval, then the same shall be reported to predefined users through messaging system described subsequently in this subsection. The exact strategy of the messaging system shall be elaborated and finalised during detailed engineering.

HMIPIS shall include on-line self surveillance, monitoring and diagnostic facility so that a failure/malfunction in any of the nodes, networking device as well as communication medium can be diagnosed on the programmer/engg. Work station/OWS.

1.06.00 **Fault Tolerance & Controllability**

1.06.01 The DDCMIS shall provide safe operation under all plant disturbances and on component failure so that under no condition the safety of plant, personnel or equipment is jeopardised. Control System shall be designed to prevent abnormal swings due to loss of Control System power supply, failure of any Control System component, open circuits/short circuits, instrument air supply failure etc. On any of these failures the control system output shall either remain in last position before failure or shall come to fully open/close or on/off state as required for the safety of plant/personnel/equipment and as finalised during detailed engineering. System shall be designed such that there will be no upset when Power is restored.

1.06.02 I/O modules shall have protection so that any fault in sensor & its wiring upto I/O module like open/short circuit, earth fault affects only that channel of I/O module. Other channels of that I/O module or other modules or other parts of system shall not be affected in any way.

1.06.03 No single failure either of equipment or power source shall be capable of rendering any part/system/sub-system of DDCMIS inoperative to any degree. No single failure in HMIPIS shall lead to non-availability of more than one OWS or one LVS. In such an event i.e., single failure leading to non-availability of any OWS/LVS, it shall be possible to operate the entire plant in all regimes of operation including emergency conditions from each of the other available OWS/LVS.

1.06.04 In order to achieve above, following shall be redundant with automatic change-over (including the associated software), as a minimum:

- Controller, Comm. Controllers, HMIPIS bus/Unit LAN, System bus, Local/Remote communication bus.
- Power supply arrangement (feeders/modules)
- Output modules. (for which redundancy is specified in part-A-Contract quantities for DDCMIS).
- Servers/information work stations

However, following need not be redundant:

- I/O bus, (if it is a backplane bus & extension/joining of such backplane buses cabinet/adjacent cabinet) and input modules.

1.06.05 The system design shall ensure that no single failure, whatsoever in any part of DDCMIS result in loss of communication except communication between HMI and control system, for which loss of communication upto a maximum of five seconds is acceptable. However, during this period, the control system shall remain fully functional and this event shall not create any disturbance/malfunction whatsoever (e.g., accumulation of control commands, issue of spurious commands/signals etc.).

1.06.06 DDCMIS shall meet all requirements stipulated under other Sub-sections/sections of the specification including Sub-Section-IV, Part-A, (including the requirement Authorisation to shipment test ATST) Quality assurance (sub-section-III-E Part B, Section VI of technical specifications) & General Technical Requirements (Part C Section VI of Technical Specifications).

1.07.00 **Signal Exchange**

All the signal exchange between various functional groups of each control systems shall be implemented through redundant system bus.

1.08.00 **System Spare Capacity**

1.08.01 Over and above the equipment and accessories required to meet the fully implemented system as per specification requirements, DDCMIS shall have spare “Usable” capacity and necessary hardware/ equipment/ accessories to meet following requirement for future expansion at site:

1.08.02 10 % spare channel shall be provided in each functional groups for each type of input / output fully wired upto the marshalling/ termination TBs .

1.08.03 Wired-in "usable" space for 20% modules along with Field Terminal assemblies, PCB/Connectors (if any in the offered system) in each of the system cabinets for mounting electronic modules shall be provided by the Contractor for future use.

1.08.04	Each controller shall have 20% spare functional capacity to implement additional function blocks, over and above implemented logic/ loops. Further, each controller shall have spare capacity to handle minimum 30% additional inputs/ outputs of each type mentioned in clause 1.08.02 & 1.08.03 above, over and above implemented capacity. Each of the corresponding communication controllers shall also have same spare capacity as that of controller.
1.08.05	Ten (10) percent spare relays of each type and rating, mounted and wired in relay cabinets. All contacts of relays shall be terminated in terminal blocks of relay cabinets. In each of the relay cabinets, 10 % spare terminal blocks shall be provided so that additional relays can be mounted and wired.
1.09.00	Twenty (20) percent spare terminal blocks in each marshalling cabinets.
1.10.00	The spare capacity as specified above shall be uniformly distributed throughout all functional groups. The system design shall ensure that above mentioned additions shall not require any additional controller/processor/ peripheral drivers/ cabinets in the system delivered at site. Further, these additions shall not deteriorate the system parametric requirements like response time / duty cycle, etc. from those stipulated under this specification and shall meet other redundancy / functional requirement.
1.11.00	DDCMIS shall meet system performance and parametric requirements as stipulated under Performance Guarantees under Part-A, Section-VI, Sub-Section-IV of specifications. Also the Authorisation to shipment tests shall be performed in line with the Chapter-III-E, Part-B, Section-VI.
2.00.00	**SYSTEM DESCRIPTION**
2.01.00	The DDCMIS shall include following main constituents. (Also refer DDCMIS configuration drg.no. x-y-POI-A-001). The DDCMIS shall work in full integration and conjunction with field equipment/drives like pumps, motors, valves, actuators, dampers, hydraulic control systems and field instruments.
2.02.00	**Control System**
2.02.01	The Control system along with its measurement system shall perform functions of closed loop control, sequence control, interlock & protection of the Plant and auxiliaries in all regimes of its operation.
2.02.02	The measurement system of control system shall perform the functions of signal acquisition, conditioning and signal distribution of various types of inputs/outputs like analog, (4-20 mA DC- either from pressure / DP/ flow / level transmitters, analysers etc. as well as from temperature transmitters for all temperature) measurements from thermocouple, RTD to be connected to this system), binary, pulse, digital transmission through serial port, bus connection etc. (from remote I/O etc., Through various industry standard protect including MODBUS/FIELDBUS/PROFIBUS, prefabs freed and Ethernet etc. The inputs, which are required for only information & monitoring purposes, shall be distributed suitably in various groups plant area-wise.
2.02.03	The control system shall also perform logic & computation for annunciation functions.

2.02.04	The control system hardware (controllers, modules/cards etc.) shall be housed in cabinets located in respective control equipment room (CER) unitised and offsite except for the remote I/O cubicles (as specified in Part-A) which shall be located in respective areas.
2.03.00	**Human-Machine Interface and Plant Information System (HMIPIS)**
2.03.01	The HMIPIS shall perform control, monitoring and operation of the Plant and auxiliaries in all regimes of its operation, interacting with the Control System. For this, HMIPIS shall primarily perform following functions:
2.03.02	Operator interface for Control System
2.03.03	Plant Supervisory functions like displays, alarm monitoring & reporting, reports & logs, calculations, trend recording, historical and long term data storage & retrieval, etc.
2.04.00	**System Programming & Documentation Facility**
2.04.01	The programmer stations shall be provided for On-line configuration & tuning of Control System and On-line program development/modifications in HMIPIS.
2.05.00	**Data Communication System (DCS)**
2.05.01	The Data Communication System shall be provided for communication between Control System and HMIPIS, communication & signal exchange between various functional groups as well as communication between various units & off site / off line systems.
2.06.00	**Annunciation System**
	The annunciation logic will be implemented as a part of DDCMIS and annunciation shall be made available on all OWS/LVS.
2.07.00	**Power supply:**
2.07.01	Power supply of control system shall be based on 24V DC. The Power supply along with its associated circuitry is intended to provide the following functionalities (a) Isolation between input & output side and distribution. (b) Multiple voltages as required by various modules as well as integration/supply voltage to field devices. (c) Auctioneering of dual voltages. (d) Providing stabilized/regulated power to Control System, taking care of input power supply variations.
2.07.02	The Control System shall be fed from 24V DC power supply system; however if it is Contractor's standard practice to use 230 V AC UPS power supply, the same will also be acceptable(please refer power supply section of specification). The complete Control System, including power supply for various modules & field interrogation, shall be through regulated power supply using power supply modules/packs. Further, the monitoring of

individual feeders of input power supply shall be done as specified at clause 1.05.01 (c) of IIIC-02.

3.00.00 MEASUREMENT FUNCTIONS OF CONTROL SYSTEM

3.01.00 The input / output modules employed in the Control System shall be separate from controller hardware.

3.01.01 The functions listed below shall generally be performed in I/O modules. However, some of the functions can be implemented in the controllers.

3.02.00 **Analog signal conditioning & processing**

3.02.01 The conditioning and processing functions to be performed as a minimum for the analog inputs coming for control and information purposes are:

1. : Galvanic isolation of input and output signals for which power supply source is other than the measurement system of the control system.
2. : Transmitter power supply with per point fuse protection or current limiting and power supply monitoring.
3. : Monitor sensor wire break/open circuit/short circuit and take suitable actions in logic/loop. (This will include blocking of trip signals in case of RTD failure).

3.02.02 All analog signals for control purpose shall be acquired, validated, processed and their respective Controller data base updated at a maximum interval of 250 milli seconds except for some fast-acting control loops for which the above-referred time shall be as per process requirement. For signals required for information only, the above functions shall be performed at an interval of 1 seconds. The HMI database updation shall not take more than one (1) second. The validated analog inputs shall be converted into engineering units on a per point basis. Analog input processing (scanning to alarm checking) shall be performed once every scan cycle. It shall be possible to manually disable any analog input either through deleting from scan or substitution from HMI.

3.02.03 The analog 4-20 mA input cards shall have input resistance >= 250 ohm inside the card/FTA (as applicable) for interfacing transmitters/analysers/temp. signals (through temp transmitters) giving 4-20mA analog signal along with superimposed HART interface signals. 4-20 mA DC signal will only be used for control purpose and superimposed HART signal will be used for configuration, maintenance, diagnostic and record keeping facility for electronic transmitters and Analysers etc.

3.03.00 **Binary signal conditioning & processing**

3.03.01 The binary inputs shall be wired either in form of changeover type contacts (i.e. 'NC' + 'NO' together) or non-changeover type Contact ('NC' or 'NO') depending on the requirement, as defined in Part-A of specification.

3.03.02 The conditioning and processing functions to be performed as a minimum for the binary inputs coming for control and information purposes are:

1. : 24 VDC power supply for contact interrogation for all potential free contacts with

per point fuse protection or suitable current limit feature/ isolation through opto-coupler.

2. : Contact bounce filtering. (The field **contact** which is changing state must remain in the new state for the filter delay time to be reported as one event). The filter delay time should be suitable for the field input & its scan rate.

3. : Facility for automatic pegging the binary signal to logic one/zero or last correct value in case of failure of binary input module.

4. : All binary signals shall be acquired validated, processed, alarm checked and their data base updated within one second.

5. : It shall be possible to manually disable any binary input either through deleting from scan or substitution from HMI.

3.04.00 **Not used**

3.05.00 **Multiple Measurement Scheme**

Triple / Dual measurement schemes shall be provided for triple / dual redundant sensors used in closed loop and open loop controls.

The triple / dual measurement schemes for closed loop control shall provide median / average outputs. The operator shall be able to select any of the transmitters or the median/average value from the LVS/OWS.

The sensors for multiple measurement schemes for open loop controls shall always be in service (except when gone Bad /cable cut) and operator shall not be able to select / deselect any of the sensors. Further, measurement scheme shall be implemented considering safety / availability aspects.

Individual transmitter signals, their status and selected value for control/ measurement and shall be available on LVS/OWS in the CLCS displays and the popups

3.06.00 Wiring Scheme for inputs to control system

Each of the triple redundant binary & analog inputs shall be wired to separate input modules. Similarly each of the dual redundant binary & analog inputs shall be wired to separate input modules. Implementation of multiple measurement schemes of these inputs will be performed in the redundant hardware. Loss of one input module shall not affect the signal to other modules. No single failure in any component of the control system shall lead to unavailability of more than one of dual/triple redundant input signals to Control System.

3.07.00. The maximum number of inputs/outputs to be connected to each type of I/O module shall be as follows:

1	:	Analog input module	16
2	:	Analog output module	16

	3	:	Binary input module 32
	4	:	Binary output module 32
	5	:	Analog input & output (combined) module 16
	6	:	Binary input and output (combined) module 32

Note: For binary inputs, one changeover contact is counted as 2 inputs.

The following requirements shall be met for analog/binary input/output modules as applicable.

Input filters to attenuate noise shall be provided.

All analog outputs shall be short circuit proof.

3.08.00 The Control Desk mounted hardwired devices & stations shall be interfaced through the I/O modules. No signal multiplication shall be done at marshalling end input termination end.

4.00.00 CONTROL SYSTEM REQUIREMENTS

4.01.00 The control system shall be broadly divided into the followings:-

4.01.01 (i) Close Loop Control System (CLCS) - Modulating control functions for various applications including individual control and operation of modulating drives.

(ii) Open Loop Control System (OLCS) - Binary control functions pertaining to sequence / interlock / protection of plant auxiliaries for various applications including individual control and operation of binary drives.

(iii) Other functions as per various requirements specified in Part-A of specification.

(iv) Performing logic & computation for annunciation functions & other miscellaneous Controls, signal processing etc.

4.01.02 The Contractor shall provide all hardware/software, whether or not specifically indicated in this specification to fully meet operational/maintenance/ safety requirement as well as statutory/international standard and proven practices.

4.01.03 The Control System shall function reliably under the environmental conditions as specified in Sub-Section:- Basic Design Criteria of this specification. It shall be immune from the interference resulting from disturbances in power supply feeders, signals lines, inputs, outputs etc. as experienced in a coal fired power station. It shall be able to withstand power line disturbances.

4.01.04 The Control System shall have on-line simulation & testing facility.

4.01.05	The system shall have the flexibility to easily reconfigure any controller at any time without requiring additional hardware or system wiring changes and without disabling other devices from their normal operation mode. Modifications shall not require switching off power to any part of the system.
4.01.06	Power supply to individual functional group shall be from redundant power supply feeders with diode auctioneering and further sub-distribution. The scheme should be such that on failure of one of the redundant power pack/ module also, both the controllers and all components of Control System continue to receive power without any interruption.
4.01.07	The assignment of I/O channels for Inputs/Outputs, arrangement of modules within cabinet etc. shall be identical for all units except those inputs/outputs which are common for all units. Further uniformity should be maintained for redundant stream of process equipment within a unit.
4.01.08	The application programs for the functional controllers shall be software based which shall be maintained even through power supply failure.
4.01.09	Independent and dedicated controllers (main and its 100% standby) shall be provided for each of the functional group (FG) of Control System except for the cases where triple redundant controllers are to be used as per this specifications. All the 100% hot redundant backup controllers shall be identical in hardware and software implementation to their corresponding main controllers and shall be able to perform all its tasks. The backup controller shall track its corresponding main controller. There shall be an automatic and bumpless switchover from the main controller to its corresponding backup controller in case of main controller failure and vice versa without resulting in any change in control status. In case of switchover from main controller to the 100% hot backup controller, the back-up controller shall work as the main controller. Further, when only one controller is working and other controller is inserted on line (for example after repair/replacement), there should not be any degradation in the function of the working controller & control operation.
4.01.10	The loop/logic reaction time (from change of input to input module to the corresponding control command output) shall be suitable to match actual process requirements, subject to minimum requirement wherever specified.
4.02.00	The major auxiliaries / logics to be controlled from control system have been indicated in Part-A of specification. The exact implementation of the logics, drive functions, monitoring etc will be to meet actual process requirements and as finalised during detail engineering stage. If control of electrical system is included (refer part-A) then functions such as open/close or on/off etc. of various electrical systems such as breakers and isolators, Raise/ lower for equipment like transformers tap changer, synchronization of electrical breakers, etc. shall be provided. Control and all the operation, in case of electrical system, shall be performed through LVS/OWS.
4.03.00	The major control loops to be controlled from Control System have been indicated in Part-A of specification. However, exact implementation of these control loops shall be finalised during detailed engg. Stage in consultation with main equipment supplier. The Contractor shall furnish his standard & proven implementation practices for similar control loops in

power stations. The Contractors shall be responsible for final implementation of control loops which shall meet all specification requirements.

4.04.00 The measurement system of control system should be capable of acquiring data from various equipment & system in digital form through serial port, Ethernet connection using industry standard protocols. The control system shall include requisite modules for accepting such signals. Examples of such signals will be from remote I/O signals (through extended I/O bus), , fault/diagnostic signals from vibration monitoring system, UPS/DC system etc.

4.05.00 **Binary Controls/Open Loop Control System (OLCS) Functions**

4.05.01 These clauses are applicable for all the Binary controls of DDCMIS included in Contractor's Scope.

4.05.02 The OLCS shall include sequence control, interlock & protection for various plant auxiliaries/valves/dampers/drives etc. The sequence control shall provide safe and automatic startup and shutdown of plant and of plant items associated with a plant group. The interlock and protection system shall ensure safe operation of plant/plant items at all times and shall automatically shut down plant/plant items when unsafe conditions arise.

4.05.03 The OLCS shall be arranged in the hierarchical control structure consisting of unit level, group level, subgroup level & drive level (as applicable).

4.05.04 The group level shall control a set of functional sub-groups of drives. Appropriate start-up and shut down commands shall be issued to the sub-group control and various check-backs shall be received from sub-groups or drives. Each sub-group shall execute the sequential start-up and shut down programs of a set of inter-related drives along with system interlocks and protections associated with that sub-group as well as basic interlocks and protections related to individual drive falling under that sub-group. The drive level shall accept commands from the sub-groups, push buttons (wherever provided), etc., and transmit them to the respective drive, after taking into account various per missives and protections of that particular drive. For HT and other critical drives, first-up logic shall be incorporated to indicate the cause of protection/trip.

4.05.05 **Sequence Control**

(a.) A sequence shall be used to move a set of groups, sub-groups from an initial steady state (for instance 'OFF') to a final steady state (for instance 'ON'). The sequence initiating command for the unit & group level shall be issued from LVS/OWS.

(b.) A sequence shall be made of steps. The steps shall be executed in predetermined order according to logic criteria and monitoring time consisting of the interlock & protection requirements and check back of previous step which shall act as preconditions before the sequence control can execute the command for that step.

(c.) Each step shall have a "waiting time" implying that the subsequent step would not be executed unless the specified time elapses. A monitoring time shall also be defined as the maximum time required in executing the commands of any step and the time

required for appearance of check back signals. In case, this is not completed within the specified time, a message shall be displayed and program will not proceed further.

(d.) Manual intervention shall be possible at any stage of operation and the sequence control shall be able to continue at the correct point in the program on return to automatic control. Protection commands shall have priority over manual commands, and manual commands shall prevail over auto commands.

(e.) Open or close priority shall be selectable for each drive.

(f.) The sequence startup mode shall be of the following types.

i) Automatic Mode

ii) Semi-Automatic Mode

iii) Operator Guide Mode/Test Mode

4.05.06 For the drives, the command shall be provided through O/P module to the coupling relays in MCC/SWGR/Actuator/Relay Cabinets as applicable and inputs (status, SWGR & process) shall be acquired through input modules. Redundancy in drive outputs shall be provided for crtical drives as decided during detail engineering, however the total number of such drives shall not exceed 10 % of total drives. The failure of one of the redundant, output module shall in no way affect the function of the other output module, wherever redundancy is provided.

4.05.07 The output modules shall have the feature that ensures that in case of failure, all the outputs are driven to zero. The 24V DC command outputs to drives for ON/OPEN, OFF/CLOSE shall be separate and independent and inverted outputs shall not be employed. Live +24V DC outputs shall be provided to MCC/SWGR/ actuator as applicable when command is to be issued. Keeping +24V DC extended to the relays for these outputs continuously & extending ground/negative when command is to be issued, is not acceptable except some of the auxiliary plants as to be decided during detailed Engineering.

4.05.08 For inching type of drives, position transmitter power supply and monitoring of position transmitter signal shall be provided.

4.05.09 The sequence interlock & protection requirements shall be finalised during detailed engineering and the same shall be subject to Employer's approval.

4.05.10 The drive function i.e. basic interlock & protection logic of the drive shall be implemented in redundant controllers. The drive function shall ensure that protection signals for the safety of the drive shall be effective under all conditions and under all modes of operation. The different commands shall be performed according to the priority of protection 'Off', Protection 'On', manual and automatic. The standard functions like running time monitoring, status signaling, alarm/drive annunciation, etc. shall be performed in drive function. The drive function shall prevent hunting of the actuator in the presence of both open & close commands for actuators of the valves & dampers. The drive function shall be implemented in dedicated standard software functional block (drive macros).

4.05.11	It shall be possible to control all common system drives (i.e. common for more than one units), from all or some of the units.
4.06.00	**Modulating Controls/Closed Loop Control System (CLCS) Functions**
4.06.01	This Clause is applicable for all analog controls of DDCMIS.
4.06.02	The CLCS shall continuously act on valves, dampers or other mechanical modulating devices such as hydraulic couplings etc., which alter the plant operation conditions. The system shall be designed to give stable control action in steady state condition and for load changes in step/ramp over complete load range up to 100% MCR. The system shall have the following minimum features :
4.06.03	The controller capability shall, as a minimum, include (i) P, PI, PD and PID control functions and their variations (ii) cascade control (iii) feed forward control (iv) On-Off control, (v) Ratio and bias control, (vi) Logical operation. Other advanced control strategy like adaptive & predictive control etc. can be considered for important loops like Furnace Draft, combustion control, FW flow control etc. in addition to SH/RH temperature control.
4.06.04	The control loop shall have enough flexibility and various features to perform feed forward, balancing of controller, increasing the response to achieve the desired process parameter within prescribed time frame.
4.06.05	The control system shall be bumplessly transferred to manual on the conditions of Control power supply failure, Failure of redundant controllers, Field input signal not available, Analog input and / or deviation exceeding preset value, etc. as a minimum and as finalised during detailed engineering.
4.06.06	Any switch over from auto to manual, manual to auto and switchover from LVS / OWS operation to H/A station operation and vice versa shall be bumpless and without resulting in any change in the plant regulations and the same shall be reported to the operator and recorded automatically.
4.06.07	Analog output (positioning signal) of 4-20mADC shall be provided from CLCS to the respective microprocessor based positioner E/P converters / electrical actuators as applicable. Redundancy in drive outputs shall be provided for drives as quantified in Part-A. The failure of one of the redundant, output module shall in no way affect the function of the other output module, wherever redundancy is provided. CLCS shall also provide all the necessary outputs for indicators and other devices as specified in Part-A with output loop resistance of 500 ohms for each channel of the output module.
4.06.08	The System being supplied shall be such that when permissible limits are exceeded, an automatic switchover from an operation governed by maximum efficiency, to an operation governed by safety and availability is affected.
4.06.09	For safety reasons, switchover logics associated with the modulating control loops shall be performed within the same controller. Modulating control loops shall be provided with standard features to interface overriding commands from OLCS/SG/TG Protection System like open, protection open etc.

4.06.10 All controllers shall be freely configurable with respect to requisite control algorithms.

4.07.00 Automatic Turbine Runup System (ATRS)

ATRS shall run the turbine automatically from zero speed to synchronizing speed and then load the machine up to block loading and continuously check the operation up to 100% MCR without impairing the life of the turbine.

The automatic turbine run up system shall be designed in general to provide for the following functions. The implementation of following functions shall also be in accordance with other requirements specified under relevant mechanical chapters. In case of no such requirements are there in the specification then bidder's standard and proven implementation is also acceptable as decided during detailed engineering.

a Automatic start up/shut down sequence

b Stress/temperature margin controlled acceleration as per the pre selected mode i.e. slow, normal and fast.

c Stress/temperature margin controlled loading/unloading

d Automatic synchronisation and loading up to 100% MCR.

e Unloading and shut down of the machine.

5.00.00 HUMAN-MACHINE INTERFACE AND PLANT INFORMATION SYSTEM (HMIPIS) REQUIREMENTS

5.01.00 **Operator interface to the Control System**

5.01.01 The following functions shall be provided as a minimum:

All OWS/LVS of the HMIPIS shall be fully interchangeable i.e. all operator functions including control, monitoring and operation of any plant area or drive shall be possible from any of the OWS/LVS at any point of time without the necessity of any action like downloading of additional files.

5.01.02 Further, simultaneous operation (availability of popup window/faceplate) of multiple drives of control system shall be possible from a single display.

5.01.03 The system shall have built-in safety features that will allow/disallow certain functions and entry fields within a function to be under password control to protect against inadvertent and unauthorised use of these functions. Assignment of allowable functions and entry fields shall be on the basis of user profile. The system security shall contain various user levels with specific rights which shall be as finalized by the Employer during detailed engineering. However, no. of user levels, no. of users in a level and rights for each level shall be changeable by the programmer (Administrator). The users created for a particular user level shall be specific to a DDCMIS. Hence, a user of one DDCMIS shall not be able to exercise the same privileges in other DDCMIS(s). The rights of each user shall contain two types of privileges as follows :-

a) Privileges for the DDCMIS

b) Privileges for the Operating System features.

5.01.04 Typically following user levels shall be available:

a) Operator

b) Supervisor

c) Maintenance Engineer

d) Shift Incharge/Station Incharge/other Monitoring Users.

e) Programmer

5.01.05 The system shall have functionality to configure view only privilege of any sub-system from HMI of any other sub-system. In case Cross HMI operation is applicable as per Part-A, it shall be possible to enable/disable operation of any valve or drive or area belonging to any sub-system from the HMI of any other sub-systems by a supervisory command through station LAN. Such control shall be based on a pre-engineered list and as per pre-predefined priority hierarchy. In case, cross HMI operation privilege is not available for a particular drive/area and still an operation is attempted for the drive/area then a suitable regret message should be displayed in HMI to the operator. It shall be possible to modify the list at site under Maintenance Engineers/ Administrator's right.

The Contractor shall implement all necessary logics & selection facility in Control System/HMIPIS for the same with safeguard to prevent multiple operations simultaneously. Status & other signals related to the drive and the selection by any other user shall be made available to other users.

5.02.00 The following functions shall be provided:

a) Calculations: Basic calculations like time of max./min., number of transgression of a point in a band etc. shall be provided. Same can be implemented in control system also. These calculated points shall be capable of being assigned to any functions like any other scanned point.

b) Displays such as mimics, bar chart displays, X-t plots with various update rates using the data from historian, X-Y plots (with superimposed operating curves).

c) Control related displays like faceplates for different types of drives, sequence displays, drive level displays (pop-ups giving details of auto/ protection/ permissive condition/ faults), control type display (giving details of A/M selection, process value, set point, deviation, command output, position feedback etc). Further, CLCS displays giving the single line diagram of the control loop shall be provided.

d) System status displays: This will provide an indication of the faults in a graphical form.

e) Trend alarms: Facility of Trend alarms shall be provided in DDCMIS for slowly varying process parameters, so that appropriate corrective actions are taken in time. These alarms shall be suitably provided in OWS/LVS, which will be decided during detailed Engg. Stage

5.02.01 **LVS/OWS Annunciation Display**

The LVS/OWS annunciation will replicate in software the salient features of conventional hardware annunciations facia (for permanent viewing i.e., not operator changeable) while presenting more flexibility. This annunciation shall include both the process alarms as well as system alarms. The top area of the OWS and LVS (around 20-25%), shall be reserved for these display.

The annunciation system shall be implemented as an in-built function of DDCMIS. The field contacts shall be acquired through DDCMIS only. The annunciation points will be presented on topmost area of mimics display. The annunciation area will be divided in three (3) “alarm bands”. The annunciation sequence shall be as discussed and finalized during detailed engineering.

Bidder shall provide suitable “configuration utility” for viewing and modifying list of all alarms (process and system) to be displayed on all annunciation area, band color, text color, flashing color and frequency, font, etc.

5.02.02 **Displays On large Video Screen**

LVS based overview displays shall be provided, which shall be overlaid across all the LVS for viewing as video wall.

5.03.00 Facility of time activated logs (Daily & Shift logs), event activated logs (Post trip log) shall be provided. At any point of time, log/ report can be demanded by operator. Maintenance data log shall be provided for total running timer & other maintenance related statistics. This shall also include standby running hours.

5.04.00 **Historical storage and retrieval system (HSRS)**

Complete HSRS functionality shall be implemented in server/information work station (Please refer Part-A for redundancy requirements). The data shall be saved online on hard disk and transferred to the portable storage device like DVD periodically for long term storage. Provision shall be made to notify the operator when the portable disk is required to be replaced with a fresh disk. The Hard disk capacity shall be sufficient to store at least One(1) year data Suitable facility for retrieval of data shall also be provided.

The data to be stored in the above system shall include alarm and event list, periodic plant data (tags computed in control system as well as computed in HMIPIS) including data required for Residual life assessment, logs/reports etc. The data/information to be stored & frequency of storage and retrieval shall be as finalized during detailed engineering.

6.00.00 PROGRAMMER'S STATION (PROGRAM DEVELOPMENT/ MODIFICATION, SYSTEM MAINTENANCE AND DOCUMENTATION FACILITY)

6.01.01 The structuring/configuration/modification of Control loops/logics in Control system and program development/modification in HMIPIS shall be possible from fully graphic displays using familiar & conventional functional blocks.

6.01.02	Any modification done in Control System and HMIPIS shall be suitably logged so that it can be traced to the user log-in ID and time of change.
6.02.00	**Control system structuring/configuration/tuning facilities**
6.02.01	Structuring/configuring and tuning facilities shall be provided for structuring/ modification, storing/loading, testing, tuning, monitoring, etc. of all the microprocessor-based controllers of the control system.
6.02.02	It shall be possible to configure the system with ease without any special knowledge of programming or high level languages.
6.02.03	On-line tuning of the control loops shall be possible without causing any disturbance in the execution of the control loops. Provision to store and retrieve on immediate and long term basis the system configuration, data base etc. on some device such as floppy disk shall be included. Facility shall be provided to reload/down-load the system or controller module from the already stored data, on-line.
6.02.04	Facility for modification shall be user-friendly. For example, modification of logics/loops etc., zooming for better display, stretching etc. should be possible. It shall be possible to add/modify, delete blocks in logics/loops on-line
6.03.00	**System Documentation Facility**
6.03.01	The system shall have the facility to generate the associated documentation for both the Control System & HMIPIS with all required software and hardware tools for viewing and printing drawings and documents..
7.00.00	**DATA COMMUNICATION SYSTEM (DCS)**
7.01.00	The Data Communication System shall include a redundant System Bus for major subsystems with hot back-up. Other applicable bus systems like cubicle bus, local bus, I/O bus etc shall be redundant except for backplane buses which can be non-redundant. The system shall have the following minimum features:
7.01.01	Redundant communication controllers shall be provided to handle the communication between each functional group of controllers of Control System and the System Bus.
7.01.02	Failure of one bus and changeover to the standby system bus shall be automatic and completely bumpless.
7.01.03	The following buses shall be fiber-optic only. (a) System bus from locally mounted control system cabinets/OWS to central location. (b) I/O Bus from remote I/Os to centrally located system cabinets.
7.01.04	The redundant buses shall be physically separate and shall be routed separately.

8.00.00	**POWER SUPPLY, GROUNDING, CABINET/PANELS, ETC.**
8.01.01	**Power Supply**
8.01.02	Contractor shall provide totally reliable & quality power supply for DDCMIS.
8.01.03	Wherever hot backup or redundant equipment likes controllers, processors, I/O modules, etc. have been specified and provided, the same shall be powered through separate power supply feeders.
8.02.00	**Grounding**
	All panels, desks, cabinets shall be provided with a continuous bare copper ground bus, bolted to the panel structure on bottom on both sides. The bolts shall face inside of panels. Further, for connection of shields of the field instrumentation cables, a separate shield bus independent of the ground bus shall be provided, which shall be connected to the earth risers by means of independent cables.
8.03.00	**System Cabinets/Panels**
8.03.01	All DDCMIS system modules, power supply components, other control devices (except field mounted sensors/transmitters) which are required for completeness of the system shall be housed in cabinets furnished by the Contractor. All equipment and dedicated cabinets required for termination, marshalling and proper interface within Contractor's system and also with other systems shall also be provided by the Contractor.
8.03.02	The cabinet mounted equipments shall be fully assembled, installed in mounting racks, wired and fully tested as per specification requirements and Employer approved drawings in the manufacturing works of a qualified manufacturer prior to shipment to the project site. The Contractor shall ensure that the cabinets are complete and ready for installation before dispatch from manufacturing works. The installation work at project site for these cabinets should only involve connections through multi pair cables from marshalling cabinets (wherever provided) to system cabinets and inter-cabinet/cabinet to Control Desk.
8.03.03	The DDCMIS cabinets shall be generally grouped into following type of cabinets: (a.) Control System Cabinets (b.) Marshalling cabinets (c.) Relay cabinets (d.) HMIPIS cabinets However, in case Bidder's system design requires the termination cabinet independent from system cabinet, the marshalling cabinets can be combined with the termination cabinet. In case, the termination arrangement is part of the system cabinet, independent marshalling

cabinets shall be provided. The HMIPIS cabinets can be clubbed with Control System Cabinets for small areas where only 24V dc power supply is used.

For this plant Contractor may propose other types of cabinet design which meets the intent of this specification viz., clean & systematic field wiring, ease of maintenance,etc.

8.03.04 Hardware like network components, power supply distribution etc. shall be suitably housed in cabinets/enclosures. In network cabinets suitable arrangements shall be provided to ensure that the network components are visible in door closed condition (e.g. Glass doors etc), as approved by Employer

8.03.05 Relay cabinets (or marshalling / termination cabinet cum relay cabinets, as the case may be) shall house all the interfacing relays in the system.

8.03.06 **Marshalling**

All the incoming / outgoing signals shall be grouped as per their origin / destination and will be terminated in the marshalling cabinets (or marshalling cum termination cabinet as the case may be). The grouping of these signals shall be subject to Employer's approval. The Contractor may make a special note that termination of field cables directly to the system cabinet (whether on TBs or on the pins on I/O modules) is not envisaged, unless specifically permitted by Employer due to strong reason presented by Contractor.

System cabinet(s) and corresponding marshalling and termination cabinet(s) shall be a single shipping section, so that the internal wiring from field terminal to the module is done completely at the factory itself.

The system cabinets shall be furnished with side panels even within a shipping section.

8.03.07 Contractor shall design the cabinet internal arrangement, floor cutout and cable gland plate such that all the cables entering or leaving the cabinet can be properly glanded in the gland plate. In case, glanding is not possible Contractor shall indicate in his proposal his suggested procedure for cable entry and securing the cable at place.

8.03.08 The type of termination and terminal blocks to be used in the relay cum termination/ Field Termination cabinets shall be as per requirements specified under Sub-Section-Inst. Cable. The terminals used for terminating the spare cores/ pairs of field cables shall not be employed for terminating the spare channels of I/O modules/ FTMs. For terminating multipair instrumentation cables for marshalling purpose, 8-level cage-clamp type posts shall be used with min. two connections for each core of cable.

8.03.09 The protection class of cabinets and environmental rating shall be as defined in Basic Design Criteria. The Contractor shall ensure that the packaging density of equipment in these cabinets is not excessive and abnormal temperature rise, above the cabinet temperature during normal operation or air-conditioning failure, is prevented by careful design. If fans/blowers are required for satisfactory system operation, dual blowers/fan with blower failure alarm shall be provided in each cabinet with proper enclosure and details shall be furnished with proposal. Suitable louvers with wire mesh shall be provided on the cabinet.

8.03.10	The cabinets shall be totally enclosed, free standing type and shall be constructed with minimum 2 mm thick steel plate frame and 1.6 mm thick CRCA steel sheet or as per supplier's standard practice for similar applications, preferred height of the cabinet is 2200 mm. The cabinets shall be equipped with full height front and rear doors. The floor mounting arrangement for other cabinets shall be as required by the Employer and shall be furnished by the Contractor during detailed engineering.
8.03.11	Front and rear doors shall be provided with locking arrangements with a master key for all cabinets. If width of a cabinet is 600 mm or above, double doors shall be provided.
8.03.12	Two spray coats of inhibitive epoxy primer-surface shall be applied to all exterior and interior surfaces. A minimum of 2 spray coats of final finish color shall be applied to all surfaces. The final finished thickness of paint film on steel shall not be less than 65-75 micron for sheet thickness of 2 mm and 50 microns for sheet thickness of 1.6 mm. As an alternative, single coat of anodic dip coat primer along with single textured powder coating with epoxy polyester meeting the thickness requirement is also acceptable. The Bidder shall furnish sufficient touch-up paint for one complete finish coat on all exterior factory applied painted surface of each item of equipment. The finish colors for exterior and interior surfaces shall conform to following shades: Front & Rear-RAL 9002; End panel side- RAL 5012. Internal color shall be same as external color. Paint films which show sags, checks or other imperfections shall not be acceptable.
8.03.13	Cabinets shall be designed for a grounded installation on the building structure. Any isolation from the building ground which is required by equipment design shall be provided internal to the cabinet.
8.03.14	All alarm contacts located within cabinets as well as inputs/outputs from other related system shall be suitably terminated in the cabinets.
8.03.15	The Contractor may submit details of his standard wiring practice for similar application for consideration and approval of Employer.
8.04.00	Relays
8.04.01	All the relays provided by Contractor shall be suitable for control supply of 24V DC. Each relay shall have 2 changeover type contacts & the rating of contacts shall be 5 Amp at 240V AC & 0.2A at 220V DC. The VA burden of relays shall be suitable to match the capacity of output modules (however, it shall not be more than 2.5 VA). Each relay shall be provided with a freewheeling diode. The relays shall be mounted in relay cabinets except for cases where number of relays is vey less . In the cases where the number of relays is very less, the same can be mounted in termination / marshalling cabinets. All the contacts of relays shall be wired upto the cabinet terminal blocks.
9.00.00	**SYSTEM SOFTWARE REQUIREMENTS**

9.01.00 The Contractor shall provide all licensed software packages required by the system for meeting the intent, functional and parametric and performance requirements of the specification.

9.02.00 All licenses shall be valid for the continuous service life of the plant. The software licenses shall be provided for the project (e.g. organisation or site license) and shall not be hardware/machine-specific, except the operating system licenses, in the event of non-machine specific license not being supported by the operating system supplier. Necessary documentary evidence to establish the same shall be submitted by the DDCMIS supplier

9.03.00 As a customer support, the Contractor shall periodically inform and upgrade the Anti-Virus / IPS/IDS software of the workstations/servers/switches/firewall till completion of the warranty period.

9.04.00 DDCMIS supplier to qualify operating system patches/ service packs and software patches of other third party software (like Office, Adobe etc as applicable, except antivirus and IPS/IDS) for use on its system during the continuous service life of the plant, subject to availability of the same by the manufacturer of the software.

9.05.00 DDCMIS supplier should periodically inform and provide software patches for all DDCMIS software till continuous service life of the plant.

10.00.00 SYSTEM DOCUMENTATION

The Contractor shall furnish detailed system and equipment documentation. It shall include detailed system and components description covering the installation, operation, care and maintenance of all system components. All final system documentation for DDCMIS hardware and related software shall be furnished. The same shall be complete, accurate and fully representative of the supplied system and its elements. All documentation/catalogues etc., shall be furnished in English language. In addition to the hard copies, CD ROM based documentation system shall also be provided. The same should be compatible to the On-line document generation facility indicated above.

10.01.00 **Hardware documentation**

10.01.01 Detailed technical literature, reference manuals, user's guide/manuals for the complete hardware like control system hardware, HMIPIS hardware, I/O hardware, bulk memory units, peripherals and their controllers, communication hardware including controllers, man-machine interfaces programmers unit, power supply modules etc., shall be furnished by the Bidder.

10.01.02 **Operation and Maintenance manuals**

The operation and maintenance manuals shall include all information required for trouble shooting, repair and maintenance information regarding all equipments furnished for the completeness of the system. For details refer Part-C, General Technical Requirements.

10.02.00 **Software Documentation And Software Listings**

10.02.01 All technical manuals, reference manuals, user's guide etc., in English required for modification/editing/addition/deletion of features in the software of the DDCMIS shall be

furnished. The Bidder shall furnish a comprehensive list of all system/application software documentation after system finalisation for Employer's review and approval.

10.02.02 The software listings shall be submitted by the Bidder for source code of project specific application software and all special-to-project data files

11.00.00 REMOTE SERVICE CENTRE

Bidder shall provide the necessary hardware & software required for connecting the DDCMIS system to Bidder's remote service centre, through which the diagnostics & fault analysis of the DDCMIS system can be carried out. This shall include the control system and unit HMI, however the diagnostic of bought out items like LVS, LAN switches, Master & Slave Clock etc are excluded. The method of connection shall be as per Bidder's standard practice. However, it is preferred to have the connection through a single point in the plant's DDCMIS system. The fixed charges & running cost till warranty period shall be included in the Quoted Price. The running cost thereafter shall be included in contract price.

Connection for Remote access to the DDCMIS for diagnostics as described above shall be through the same firewall referred above. Virtual Private Networks(VPN) technology shall be used for data integrity and confidentiality. The type of VPN (SSL,IP Sec, SSL) ,no. of bits for encryption etc shall decided during detailed engineering. Further, this access shall be strictly under request control & record of such access shall be made available to the Employer's designated personnel. Also, it should be ensured that the hardware at the other end of the Remote access connection (i.e. at the contractor's works) shall be standalone/isolated (i.e. not connected to any network).

1.00.00 **Requirements for HMI Hardware**

1.01.00 HMIPIS Hardware

1.01.01 All the peripherals shall conform to the following minimum requirement but the exact make & model shall be as approved by Employer during detailed engineering.

1.01.02 The Servers/Worstations/PCs/Laptop to be provided by the Contractor should be latest available in the market at the time of supply to prevent early obsolescence and shall be subject to Employer's approval. The software packages to be included with the PCs shall also be the latest version available at the time of supply.

1.01.03 The actual size of the Main and Bulk Memory shall be sufficient to meet the functional and parametric requirements as specified with 25% additional working memory and 50% additional bulk memory over and above the memory capacity required for system implementation.

1.01.04 Power Fail Auto Restart (PFAR) facility with automatic time update shall be provided.

1.01.05 For Servers and Historians / Station LAN Server/ Programming station/NMS Server the hardware shall conform to the following minimum requirements:

HARDWARE REQUIREMENTS

1. Min three no. redundant; hot swappable; Hard Disk with RAID 5 implementation. Usable Hard disk capacity shall be sufficient for the application and to store at least one (1) year historical data, wherever required.

2. Redundant Hot swappable Power supply

3. Quantity of Monitor, Keyboard and Mouse (as indicated in Part-A~~, appendix~~) has to be supplied in total for the stations placed in Programmer room of Unit Area. For all other stations Monitor Keyboard and mouse are provided as per Bidder's standard Practice.

4. One intelligent SNMP manageable mini-UPS (online) for 30 minutes backup shall be provided, with all accessories and software for remote monitoring facility, with each station.

5. Additional external graphics card with dual output ports (apart from onboard graphics card) suitable to display full HD resolution in Programmer room.

SOFTWARE REQUIREMENTS

1. Application software as per the functional requirement.

2. Anti-Virus Software with IPS#

if anti-virus software cannot be provided as per standard practice of the DCS OEM suitable mitigating controls like whitelisting to be provided.

1.01.06 For Operator workstations/ Other workstations

HARDWARE REQUIREMENTS

1. Standard Hardware as recommended by the Bidder shall be acceptable.
2. Individual Monitors shall be supplied for all stations (except LVS OWS)
3. Additional external graphics card with dual output ports (apart from onboard graphics card) suitable to display full HD resolution in control room.

SOFTWARE REQUIREMENTS

1. Application software as per the functional requirement.
2. Anti-Virus Software with IPS#

   # if anti-virus software cannot be provided as per standard practice of the DCS OEM suitable mitigating controls like whitelisting to be provided.

1.01.06 For PC Station

HARDWARE REQUIREMENTS

1. Standard Hardware as recommended by the Contractor shall be acceptable.
2. One intelligent SNMP manageable mini-UPS (online) for 30 minutes backup shall be provided, with all accessories and software for remote monitoring facility, with each PC Station.

SOFTWARE REQUIREMENTS

1. Application software as per functional requirement
2. Latest MS OFFICE (Word, Excel, PowerPoint, Outlook)
3. Microsoft Visual Studio (only for Programmer PC)
4. Adobe Acrobat
5. Anti-Virus Software with IPS#

   # if anti-virus software cannot be provided as per standard practice of the DCS OEM suitable mitigating controls like whitelisting to be provided.

1.01.07 Specification for Lap-Top (Note-Book) PC

The screen size of the laptops should be 15 – 17 inches.

All the Laptop will also be used as pluggable temporary programmer's station and operator station functionalities of the programming stations mentioned in the specifications shall be provided (including requisite license).

1.01.08 **Large Video Screen (LVS)**

Large video screens, complete with projectors, screens, control units (graphical generators), Master controller, Matrix switcher & associated accessories shall be supplied as per the following specifications.

1.		Size (diagonal)		65 inch – 70 inch
2.		Type		LED illuminated Digital Light Processing (DLP) technology with rear projection configuration.
3.		Resolution of each screen		Minimum 1400 x 1050 pixels
4. .		Configuration of LVS		Single tier with screens seamlessly combined with provision of expansion of one screen on each side.
5. .		Control Unit / LVS Workstation		Same as operator work station without the TFT LCD monitor.
				Facility of projecting a particular display on a selectable area of the screen upon activation of a predefined event shall be provided.
6. .		Input signal interface		Interfacing with Video signals, to receive & project pictures from CCTV, Employer's Live camera, VCP, Flame Camera
				Signal types : PAL, NTSC or SECAM in S-VHS/VHS, Composite, Component , S-Video DVI, VGA Each cube should be capable of taking two inputs.
				Video Switcher (applicable for only Unit DDCMIS) No. of input channels : 16 No. of output channels : 4 The output of the video switcher will be connected to video wall through Master controller.

				Matrix Switcher (for Unit Control room LVS) A matrix switcher shall be provided used for connecting the control unit to the video wall. No of Inputs: 6 No. of Outputs: 6
				Remote unit for switching between video signal & HMI signal, selecting the video signal channel (live camera no./location typically) shall be provided.
7. .		Illumination level		To be finalised during detailed engineering.
8. .		Degree of viewing in horizontal & vertical		To be finalised during detailed engineering.

9. .	LVS shall be designed for continuous viewing (24 hours in a day) under normal room ambient lighting without any need to darken the room. Suitable darkening of the projection screen for light absorption shall be provided for this purpose.
10.	The LVS and its accessories shall be designed in such a way that the brightness in the centre of the screen and the edges of the screen is uniform and there is no perceivable difference in the quality of the picture on the centre and on the edges of the screen. If any extra hardware has to be provided for achieving the above feature, same shall be provided by the contractor at no extra cost.
11.	The screen should be flicker free and there shall not be any screen burn in due to display of same information for a long time.
12.	Auto brightness & color adjustment between each screen.
13. .	The hardware/software of the control unit shall be such that the command execution time of any control command from the LVS shall be same or better than the execution time from the OWS as stipulated under 'Guarantee under category-III, Sub-section-IV, Part-A, Section-VI of specifications. If during any stage of the contract, the command response times as stated in specifications are not achieved, the contractor shall upgrade the hardware/software of the control unit in order to achieve the same at no extra cost to the Employer.
14.	Master controller unit shall be provided for controlling the entire video wall in Unit Control Room LVS. It shall be capable of projecting HMI displays over a part of screen to multiple screens. Any configuration of windows shall be possible. Facility for overlays shall be provided.

1.01.09 Printers

Sr. No	Features	Colour Laser Printer	Colour Laser Printer	Line Impact Dot Matrix Printer

1	Paper Size	A3	A4	132 column continuous fan fold type
2	Printing Speed (min.)- in normal mode for A4 size paper	6 ppm (Color) 24 ppm (B&W)	4 ppm (color) 16 ppm (B&W)	1000 LPM
3	Type	Heavy duty, at least 50000 pages/month	Heavy duty, at least 30000 pages/month	Heavy duty, at least 50000 pages/month
4	Resolution (black) (min.)	600 dpi	600 dpi	-
5	First page out time (with full graphic display)	=<1 min for color, <45 sec for BW	=<1 min for color, <45 sec for BW	
6	Paper input capacity (min.)	500 sheets	500 sheets	Continuous paper feed
7	Additional features	Automatic Duplex Printing		With printer Stand & sound proof enclosure (<60 dB)
8	Paper sheets (1 ream = 500 sheets) with each printer	20 reams (A3) 20 reams (A4)	20 reams (A4)	20 reams (132 column fan-fold)
9	Additional Cartridge/toner/ ribbon of each type as used in printer with each printer	1	1	100

1.01.10 Switches : all network switches shall have 20% spare ports for future use.

Layer-3 switches shall have the following features:

- Minimum 15 nos. Fiber Gigabit Ethernet Port. 20% spare ports are to be provided over and above the total ports used
- 10/100/1000 Base TX ports (STP) as per requirement with 20% spare

- SNMP v1, v2, v3, RMON, VLAN, Multi link Trunk support (IEEE 802.3ad – Link Aggregation)
- Broadcast/multicast storm control
- Non-Blocking wire speed
- Hot swappable dual redundant Power Supply
- RIP, OSPF, BGP
- VRRP
- PIM and DVMRP Multicast Routing
- IPV4and IPV6 ready
- Support MACsec in hardware (IEEE 802.1AE)
- 10 GB module support for future upgradeability

Expandability/stackability through a dedicated high speed expansion port.

Routable, remotely manageable, configurable.

One intelligent SNMP manageable mini-UPS for 30 minutes backup shall be provided with all accessories and software.

Secondary switches shall have the following features:

- 10/100/1000 Base TX ports (STP) as per requirement with 20% spare
- Gigabit Ethernet Port as per requirement with 20% spare
- SNMP, RMON, VLAN, Multi link Trunk support.
- Support for stacking with high throughput
- Broadcast/multicast storm control

1.01.11 Firewall :

Firewall appliance should facilitate multi-vendor, multi-application environment and should support third-party products on open alliance. It should support Active-Active configuration.

- The firewall should contain following features:
  - (a) Stateful inspection of packets.
  - (b) NAT functionality, including dynamic and static NAT translations
  - (c) Latest version of SNMP
- The firewall must send log information to a separate log server via an encrypted connection. Firewall logging must not impact firewall performance.

- Remote network access to the firewall should only be possible through the administration interface.

Firewall should also meet the following requirements.

- The firewall must not support any unencrypted means of access to the firewall.
- It should Monitors ALL network traffic-traffic at Firewalls (Internet and external networks), in the DMZ and detect known threat through deep packet inspection.
- Detects unknown threats via anomaly scanning.
- Detect unknown threats via behavior pattern to protect from zero day attacks.
- Keeps up-to-date on new threats and vulnerabilities.

1.01.12 IPS/ IDS Features :

In order to inspect all inbound and outbound network activity and identify suspicious patterns that may indicate a network or system attack from someone attempting to break into or compromise a system on the NTPC Station LAN Network, the IDS/IPS will be provided as per the Station LAN configuration.

1.01.13 Network Management Software (NMS) :

The network management software should contain the below mentioned features.

- Graphical user interface (GUI) management.
- Automated discovery and display of Ethernet topology and devices.
- Monitor traffic flow through the device
- View a device image indicating which ports are active and which modules are installed. It a particular network device is down, it should give the tools like ping/telnet options in the same screen to further diagnose the problem.
- Real-time activity and utilization statistics and graphical trends.
- Facility of providing pre-defined actions like e-mail, SMS etc. upon any event generated in the network.
- Facility of viewing logical graphs of devices like routers, web servers, according to the needs.
- The following parameters should be monitored.
  - Device status
  - Port Status
  - CPU utilization
  - Memory Utilization

- All port utilization including uplink ports.

For monitoring the parameters mentioned above, the NMS workstation should be connected to all HMIPIS switches/firewalls through management LAN which is a separate LAN from the redundant Station LAN.

1.01.14 KVM Switch

Necessary KVM switches for controlling multiple operator work stations/LVS workstations (upto four nos.) from single key board/mouse/video placed at UCD in Control Room shall be supplied. For quantity of switches refer Appendix-I. These switches are intended to be used only for keyboard multiplexing.

For extension of keyboard & mouse cables from PC rack to control desk, necessary converters shall also be provided, if required. These shall be supplied on as required basis within the quoted price.

The types of Video, keyboard and Mouse connectivity of each shall be finalized during detailed Engg. All the converters and cables required for completeness of the system shall be in scope of this package.

1.02.00 **Connection for Remote Service Centre** : Connection for Remote access to the DDCMIS for diagnostics shall be through the firewall referred above. Virtual Private Networks(VPN) technology shall be used for data integrity and confidentiality. The type of VPN (SSL,IP Sec, SSL) ,no. of bits for encryption etc shall decided during detailed engineering. Further, this access shall be strictly under request control & record of such access shall be made available to the Employer's designated personnel. Also, it should be ensured that the hardware at the other end of the Remote access connection (i.e. at the contractor's works) shall be standalone/isolated (i.e. not connected to any network).

Security Policies/Procedures and Security Audits:

In order to enforce network security in the HMI of DDCMIS, security policies and procedures are to be followed by the Contractor during the tenure of the Contract & by Employer's site personnel thereafter.

For checking compliance to the above security policies & procedures in HMI of all DDCMIS, periodic security audit by a certified auditor (as per CERT- IN panel) is to be arranged by the Contractor at the time of trial operation/PG test of C&I package. This shall include vulnerability assessment of the workstations/ servers and penetration testing DDCMIS through the firewall from a node outside the network. Suitable actions based on the findings of the security audit shall be carried out by the Contractor.

These security policies/procedures envisages formation of an Information Security team which shall comprise of vendor's personnel deputed at site during tenure of the contract and NTPC personnel thereafter. All the responsibilities of information security team have to be discharged by vendor's team during tenure of the contract and NTPC team thereafter. Even though different roles have been identified for the individual members of the information security team more than one role can be performed by the same person. It may be noted that following policies/procedures are only the operation guidelines and advisory steps to ensure maximum data security.

The following security policies shall be followed. Details of the same shall be provided during detailed engg.

1. Information Security Policy
a) Information Security Team Policy
b) Firewall Policy
c) Information Identification and Classification Policy
d) Security Policy Review Policy
e) Information Labeling and Handling Policy
f) System Planning and Acceptance Policy
g) Capacity Management Policy
h) Media Handling Policy
i) Information Security Awareness Policy
j) Third Party Access Policy
k) Change Control Policy
l) Anti Virus Policy
m) System Access Policy
n) Monitoring Policy
o) Incident Handling Policy
p) Information Backup and Restoration Policy
q) Network Access Policy
r) User Access Management Policy

1.00.00 **Requirements for Master & Slave Clock System (Refer sub section- scope of supply & services for applicability of this annexure)**

1.01.00 MASTER & SLAVE CLOCK SYSTEM

Master and Slave clock system shall be provided to ensure uniform time indication throughout the various plants facilities and time synchronization between various systems as detailed in Sub-section II Scope of Supply and Services.

The Contractor shall provide a GPS based date insensitive master and slave clock system (common for the station) with adequate number of output signal to provide uniform timing throughout the various plant facilities. The system shall be complete with receiving antennae (for receiving time from GPS or Radio signal for automatic synchronization), receiver and associated electronics, Redundant Master Clocks, Slave Clocks, interconnecting cables, cubicles, Redundant power supplies & any other accessories. However, a provision shall be kept for synchronisation of the master clock with other source as decided during detailed Engineering. The exact format/type of synchronisation of master clock with other sources & slave/other system/Switchyard disturbance recorder with master clock shall be finalised during detailed Engg. Stage. The type of time synchronization format can also be as per bidder's standard .

The Master Clock shall drive the slave display units. It shall be ensured that loss of any slave display unit does not affect the display of any other slave unit. The character size of slave display unit shall be 100 mm.

Since the timing synchronization of many off-site facilities are being done through Unit LAN, the slave clocks may be alternatively driven by respective systems/sub-systems. All software package and licenses required to implement the above shall be provided.

List of slave clocks

10 no of slave clocks shall be at CER, HT Switchgear, Turbine Generator Area, Unit Control room, Weigh bridge, other locations as decided during detailed engineering.

SUB–SECTION – IIIC – 03

MEASURING INSTRUMENTS

1.00.00 **MEASURING INSTRUMENTS**

1.01.00 Measuring instruments/equipment and subsystems offered by the Bidder shall be from reputed experienced manufacturers of specified type and range of equipment, whose guaranteed and trouble free operation has been proven. Refer Sub-section Basic Design Criteria. Further, all instruments shall be of proven reliability, accuracy, and repeatability requiring a minimum of maintenance and shall comply with the acceptable international standards and shall be subject to Employer's approval.

1.02.00 Double root valves shall be provided for all pressure tapping where the pressure exceeds 40 Kg./sq.cm.

1.05.00 All instruments envisaged for sea water applications, shall be provided with wetted parts made of Monel/ Hastelloy C or any other material (if provenness experience of the proposed material for such applications is established by contractor).

1.06.00 For coastal areas, all instruments shall be provided with durable epoxy coating for housings and all exposed surfaces of the instruments.

1.07.00 Gauges /switches shall be provided as per proven practice of the Contractor.

2.00.00

Electronic transmitter for pressure /differential pressure /DP based flow & Level measurements

S No.	Features	Essential/Minimum Requirements
1.	Type of Transmitter	Microprocessor based 2 wire type HART protocol compatible
2	Accuracy	± 0.060 % of calibrated range (minimum) for calibrated range greater than 400 mmwc. +0.065% of calibrated range (minimum) for calibrated range greater than 250 kg/cm2. ± 0.10 % of calibrated range (minimum) for calibrated range less than 400 mmwc.
3.	Stability	0.25 % of calibrated range for 10 years for calibrated range greater than equal to 400 mmwc on standard conditions of manufacturer. 0.2 % of calibrated range for 1 years for calibrated range less than 400 mmwc on standard conditions of manufacturer. 0.15% of calibrated range for 5 years for DPT with static pressure greater than 250 kg/cm2.
4	Turn down	50:1 for span of greater than or equal to 400mmwcl. 20:1 for span below 400mmwcl. 10:1 for span greater than 250 kg/cm2

(Above mentioned (2,3,4) parameters/features of offered models shall be strictly as defined in standard published catalogue of the manufacturer only).

5	Housing	Weather proof as per IP-67, metallic housing with durable corrosion resistant coating
6.	Electrical connection	½" NPT(F)
7.	Process connection	½" NPT (F)
8.	Operating Ambient temperature	85 deg C without display. 70 deg C with display.
	Overpressure	150% of max operating pressure
9	Accessories	-Diaphragm seal, pulsation dampeners, syphon etc. as required by service and operating condition. -2 valve manifold for absolute & gauge pressure transmitters, -3-valve for DP and 5 valve manifold for level/flow applications. -The valve manifold shall be non-integral type. -For hazardous area, enclosure as described in NEC article 5.
10.	Mounting	2 inch pipe mounting with Enclosure/Rack/Canopy.
11.	Diagnostics & display	Self-Indicating feature and digital display on transmitter

Notes

- For primary air/ secondary air/flue gas/ furnace pressure applications, DP type transmitters shall be provided for pressure measurement below 2000 mmwc.
- LVDT type is not acceptable.
- Where the process fluids are corrosive, viscous, solid bearing or slurry type, diaphragm seals shall be provided. Parts below the diaphragm shall be removable for cleaning. The entire volume above the diaphragm shall be completely filled with an inert liquid suitable for the application.

2.04.01 Single Input /Dual Input Temperature transmitter

Temperature transmitter shall be provided which shall be fully compatible with thermocouples and RTDs being provided by the contractor. Temperature compensation for thermocouples shall be performed in the temperature transmitter itself. Transmitters shall be capable of

withstanding ambient temperature up to 85 deg C.

Following specifications are applicable for dual input/single input temperature transmitter.

S No.	Features	Essential/Minimum Requirements
1.	Output	2 –wire (power supply from input card of control system)with 4-20 mA output with superimposed HART protocol signal
2.	Input	Same transmitter shall be capable to handle Pt-100 RTD, Thermocouples –K, R & ,S types
3.	Housing	Weather proof as per IP-67, metallic housing with durable corrosion resistant coating
4.	Electrical connection	½" NPT(F)
5.	Diagnostics & display	Self-Indicating feature and digital display on transmitter
6.	Operating Ambient temperature	85 deg C without display. 70 deg C with display.
7.	Mounting	2 inch pipe mounting with Canopy.
8.	Accessories	As required by service and operating condition.
9.	Composite Accuracy	(Refer note 2) RTD =<0.25% of 0-250 deg C span T/C-K type =<0.2% of 0-600 deg C span CJC accuracy (for thermocouples) shall be =< 1 deg C

Notes*:*

1. In case of failure (open or burn-out) of RTD/thermocouple, transmitter shall provide low temperature output.
2. Dual input temperature transmitter shall have bump less changeover facility to second sensor in case first sensor fails. This changeover is to be alarmed.
3. Composite accuracy is to be calculated as summation of all applicable accuracies of temperature transmitter for converting sensor input to output (e.g., basic accuracy, digital accuracy, etc.) and temperature effect on these accuracies at ambient temperature of 50 deg C, based on the figure/ formula given in the standard product catalogue for span as specified above for various types of temperature elements specified. All such accuracy/ temperature effect figures in catalogue shall be first converted to deg C, and then percentage of this converted accuracy in specified span shall be calculated to compare

with the specified composite accuracy figures. All temperature transmitters shall be interchangeable (i.e. can be used for either RTD or thermocouple) and composite accuracy shall be met for each type of input as specified above.

3. Above mentioned parameters/features of offered models shall be strictly as defined in standard published catalogue of the manufacturer only.

4. Dual input temperature transmitters can also be accepted in place of single input TT.

2.04.02 Multi Input Temperature transmitter (Temperature Multiplexer)

For only information related temperature inputs fieldbus based Multi input temperature transmitters can be provided. Transmitters shall be capable of withstanding ambient temperature upto 85 deg C. Maximum number of inputs per such temperature transmitter shall be eight. These shall be mounted in standard enclosures available along with manufacturer of such TTs, with minimum IP-67 protection class.

2.05.00 Temperature Elements and accessories

2.05.01 Thermocouple

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

	6	Accessories	: Thermo well and associated fittings
	7	Standard	: IEC-584/ ANSI MC 96.1 for Thermocouple and ASME PTC-19.3 for Thermo-well

2.05.02 Resistance Temperature Detector (RTD)

Sr. No.	Features		Essential/Minimum Requirements
1	Type of RTD.	:	Four wire, Pt-100 (100 Ohms resistance at zero degree Centigrade).
2	No. of element	:	Duplex
3	Housing/Head	:	IP-65/Diecast Aluminium. Head of TE to be provided with sufficient space and arrangement to mount head mounted temperature transmitter (as applicable). Plug in connectors are to be provided for external signal cable connection. TE terminal head shall be spring loaded for positive contacts with the thermo well
4	Insulation and sheathing of RTD	:	Mineral (magnesium oxide) insulation and SS316 sheath,
5	Calibration and accuracy	:	As per As per IEC-751/ DIN-43760 Class-A for RTD
6	Accessories	:	Thermo well and associated fittings
7	Standard	:	IEC-751/ DIN-43760 for RTD and ASME PTC-19.3 for Thermo-well.

NOTES :

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

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

2.05.03 Metal Temperature Thermocouples

Metal thermocouples may be used as per standard & proven practice of Contractor.

2.06.00 Thermo well (for all process temp. elements)

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

(b) For Air & Flue gas 316 SS protecting tube with welded cap. (However contractor shall provide better material for Flue gas service if required based on the specified boiler design parameters).

(c) For furnace zone, impervious ceramic protecting tube of suitable material along with Incoloy supporting tubes and adjustable flanges.

3.00.00 ELECTRICAL METERING INSTRUMENTS

Electrical metering instruments shall be furnished in accordance with the following general specifications. However, the scope shall be governed by the Contract quantity given in appendix-1 to part-A. Application standard for electrical metering instruments shall be as per IS: 1248- 2003 (Revised). The size of each instrument shall be as approved by Employer during detailed engg. All metering instruments shall be flush panel mounting type.

3.01.00 (a) Frequency meters for Synchronization purposes: Accuracy: ± 1.5% of full scale.

(b) Synchroscope: Accuracy class: 0.5 or better.

(c) Voltmeters: Accuracy: ± 2.0% of full scale or better.

3.02.00 Synchronizing Relays

Synchronizing check relay with necessary ancillary equipment shall be provided which shall permit breakers to close after checking the requirements of synchronizing of incoming and running supply. The phase angle setting shall not exceed 10 Degree and this angle shall be adjustable and shall take the account the circuit breaker closing period. This relay shall have a response time of less than 200 milliseconds when the two system conditions are met within preset limits and with the timer disconnected. The relay shall have a frequency difference setting not exceeding 0.45% at rated value and at the minimum time setting. The relay shall have a continuously adjustable time setting range of 0.5-3 secs. Additionally, a guard relay shall be provided to prevent the closing attempt by means of synchronizing check relay when control switch is kept in closed position long before the two systems are in synchronism. The Control Voltage shall be 220V DC and PT input Voltage shall be 110 V AC.

3.03.00 **Auxiliary PTs for Measurement & Synchronization**

Applicable Standard	IS : 3156
Rated Voltage	110V
Insulation Level	660V grade
Frequency	50 Hz
Mounting	Panel Mounting
Test Voltage (Power frequency)	2.5 KV for 1 min.

Operating temperature	(-) 40 Deg C to (+) 85 Deg C
Primary Voltage	63.5 V to 115V
Secondary Voltage	63.5 V to 115V
Class of accuracy	1
Burden	25 VA
Class of Insulation	E or better

4.00.00 CONTINUOUS EMISSION MONITORING SYSTEM (CEMS):-

Continuous Emission Monitoring system consisting of the following equipments (Analysers/monitors) shall be provided for measurement of emissions in stack of each unit:-

1. SO2/NOx Analyser
2. CO analyser
3. CO2 analyser
4. Flue gas Flow Meter
5. HCL analyser
6. HF analyser
7. TOC
8. OXYGEN
9. Flue gas temperature measurement(As defined under Particulate Emission Analyser)
10. Particulate Emission (Stack Opacity) Analyser
11. Mercury Analyser
12 flow meter

Additionally, Oxygen analyzers (independent of CEMS) shall also be provided for Boiler Economizer outlet. Further temperature at stack shall be measured.

The common requirements to be met for all types of analysers (except HCL,HF&TOC ,which will be provided as per standard & proven practice of Contractor)are as below. The specific requirements to be met by each type of analyser are detailed in the subsequent clauses.

4.01.00 Common Requirements for all Analysers (except The Hcl, Hf ,TOC analyser which will be as per bidder standard proven practice)

1	Output signals	
	Analog	4-20 mA DC galvanically isolated.
2	Zero & span Adjustment	To be provided for all selectable ranges.
3	Ambient temp.	0-50°C unless defined otherwise.
4	Indication	Digital Alphanumeric Display. Display of reading in engineering units shall be provided.
5	Analyser enclosure Type/Material	Die cast Aluminium/SS. Weather protection for analyser mounted inside analyser panel shall be IP-22 or better. For all other analysers, weather protection class shall be IP-55.

6	Type of Electronics	Microprocessor based with self diagnostic.
7	Digital Signal transmission	RS232/ RS485 Modbus Protocol/ Ethernet TCP/IP protocol for bidirectional communication of stack emission data to CEMS PC .Further the measurement values of all analyzers shall be made available in DDCMIS for display.
8	Calibration	Auto & Manual (from Remote)
9	Power Supply	To be arranged by Contractor subject to Employer's approval.
10.	Others	I) All interconnection tubing and cabling between probe and analyser / analyser panel and cabling from analyser/ analyser panel to DCS (in respective unit control room) are to be provided by Contractor.
		ii) All the calibration gases required for one year continuous operation shall be provided. The calibration gas container material shall not contaminate the calibration gas.
11	Location of probe	SO2/NOx/CO/CO2-On stack at approximate elevation of 35 Mtrs. Particulate Emission (Stack Opacity) & Flow measurement -On stack at approximate elevation of 88 Mtrs Low temp O2:- ECO outlet, AH outlet and ID inlet. Mercury Analyser:- on stack at 35 Mtrs.
12	Location of the analysers (other than insitu type)/Analyser Panel.	AT 0' Mtrs near stack for CEMS
13	Compliance to standards	USEPA, TUV, MCERTS or equivalent standards
14	Type of Technology	SO2/NOx :- Hot-extractive sampling type/ Dilution Extractive/ In-situ (Path) type CO :- c CO2 :- Hot-extractive sampling type/ Dilution Extractive/ In-situ (Cross-duct) type (can be combined with CO or SO2/NOx above). Stack Opacity :- In-situ (Path)type Low temp O2 & High temp O2 :- In-situ type Note:- For Hot extractive sampling type and Dilution extractive sampling type system – The components involved in sample handling system shall be imported & further, Sample handling system design shall be vetted by Original Analyzer Manufacturer (OAM). Necessary documents shall be furnished during detailed engineering in order to establish the above requirement.

		Technical expert of OAM shall witness testing of sample handling system and validate it. Alternatively sampling handling system assembled at Original Analyzer manufacturer (OAM) works shall also be accepted.
15	Contractual conditions for CEMS system	Warranty:- As defined elsewhere in the Contract. Comprehensive Maintenance Contract:-. Refer sub-section-IIC-C&I/ Section-VI/ Part-A. This shall cover total maintenance of all hardware and software related to CEMS and shall include free repair/replacement of all components/cables/equipment etc and supply of expendable items. Availability of valid data:-AT least 95% of time during warranty and CMC period. For this purpose, contractor may take necessary steps to ensure availability. Other conditions shall remain similar to Clause 12.00.00 & 13.00.00 of IIIC-02, Part-B, Section-VI, Part-B.

4.02.00 **Specific requirements for Hot-extractive sampling type SO2/NOx, CO2 & CO analysers**

Specification Requirements	**SO2 Analyser and Nox Analyser cum monitor (combined)**	**CO2 ANALYZER**	**CO Analyser**
Type of Instrument	Sampling type - Hot Extractive type	Hot-Extractive	Hot-extractive type
Principle of Measurement	Radiation absorption	NDIR absorption	NDIR absorption
Measurement Range	0-300 ppm/ 0-1500 ppm (selectable)	0 to 40% (selectable)	0-200 ppm to 0-1000 ppm (selectable)
Accuracy	+/- 1% of FS	+/-2% of measured value	+/- 2% of FS
Linearity	+/- 1% of FS	+/- 1% of FS	+/- 1% of FS
Repeatability	≤ 1% of Span	≤ 0.5% of Span	≤ 1% of Span
Response time(up to 90% of full scale)	≤ 5 secs	≤ 5 secs	≤ 5 secs
a) Temperature Drift	+/- 2% / 10 deg.C	+/-1% in 24 hrs	+/- 2% / 10 deg.C
b) Zero Drift	< 1% span/week	< 1% span/week	< 2% span/week
c) Span Drift	< 1% measured value/week	< 1% measured value/week	< 1% measured value/week
Operating Temperature	0-300 deg.C	0-300 deg.C	0-300 deg.C

Range for probe			
Filter	Ceramic 3.5 Micron	Ceramic 3.5 Micron	Ceramic 3.5 Micron
Accessories for purging system	Purging system including Auto Scavenging facility shall be provided	Purging system including Auto Scavenging facilityshall be provided	Purging system including Auto Scavenging facility shall be provided
Sample gas inlet temperature to analyser	Temperature of the sample gas inlet to analyser shall be controlled before analyser as per manufacturer standards.	Temperature of the sample gas inlet to analyser shall be controlled before analyser as per manufacturer standards.	Temperature of the sample gas inlet to analyser shall be controlled before analyser as per manufacturer standards.

4.03.00 **Specific requirements for Dilution Extractive type SOx/NOx/CO2 & CO Analsyers**

The design of the Dilution Extractive type system shall be satisfying the following requirements. The sampling system shall consist of In-situ dilution probe, dilution probe controller, sample conditioning system like air drier and filters etc and other accessories meeting the following requirements as a minimum. All system components and accessories required for completion of this system shall be furnished although these may not be individually specified herein. Following are the minimum requirements.

a) Modular Electronic Design.

b) Heatless Air dryer with inlet filter, chemical scrubbers to remove traces of NOx/CO2/SO2 from air and accumulator

c) Self test facility with screen display

d) Protection of instrument in case ambient or surrounding temp going high beyond stipulated limit

e) The following are the minimum requirement for the probe:-

- Flange and counter flange for inserting probe
- Coarse and Fine filters
- Critical orifice
- Automatic blow back or purging facility
- SS316L probe material

f) Further dilution probe controller shall be provided with the ability to control dilution ratio

(g) Unheated umbilical chord to be provided for transportation of the diluted sample, zero air, vacuum pressure, and calibration gas. This chord has to be a single bundle in FRLS PVC outer sheath. The sample line has to be of PTFE.

Specification Requirements	SO2 Analsyer	NOx Analsyer	CO2 Analsyer	CO Analsyer
Principle of measurement	Pulsed/UV Fluorescence technology.	Chemiluminescence technology.	Gas Filter correlation	Gas Filter Correlation technology
Measurement Range	0-1500 ppm (selectable)	0-500 ppm (selectable)	0 to 40% (selectable)	0-200 ppm to 0-1000 ppm (selectable)
Probe operating temp	0-300 deg C	0-300 deg C	0-300 deg C	0-300 deg.C
Zero drift	<1 ppb/day	< 0.5 ppb/day	<=1 ppm/day	<0.1 ppm/day
span drift	+/-1% FS/day	+/-1% FS/ day	+/-2% FS/day	+/-1%FS/day
Lower detection limit.	<=1.0 ppb	<=0.4 ppb	<=1 ppm	0.05 ppm
Response time(up to 95% of full scale)	100 sec	60 sec	90 sec	60 sec
Accuracy/Precision.	+/- 1%	+/- 1%	+/- 1%	+/- 1%
Linearity	+/- 1% Full scale	+/- 1% Full scale	+/- 1.5% Full scale	+/- 1% of Full scale
Sample gas inlet temperature to analyser	5 deg.C - 40 deg.C	5 deg.C - 40 deg.C	5 deg.C - 40 deg.C	5 deg.- 40 deg.C

4.04.00 **Specific requirements for In-situ (Path) type SO2/NOx, CO2 & CO analysers**

Specification Requirements	CO Analyser cum monitor	SO2/NOx Analyser cum monitor	CO2 Analyser cum monitor
Principle of Measurement	IR absorption	Differential Optical Absorption Spectroscopy	Differential Optical Absorption Spectroscopy
Measurement Range	0-200, 0-1000 ppm, (selectable)	0-300 ppm/ 0-1500 ppm (selectable)	0-40% (selectable)
Accuracy	+/- 5% of FS	<= 2% of measured value for SO2 and +/- 5% for NO2	
Linearity	+/-2% of FS	+/-1% of measurement	+/-1% of measurement

		span	span
Repeatability	≤ 0.5% of Span		
Response time(up to 90% of full scale)	≤ 5 sec		
a) Temperature Drift	Automatic temp compensation		
b) Zero Drift	<1% span/week		
c) Span Drift	< 1% measured value / week		
Probe Operating Temperature Range	0 to 300 deg C	0 to 300 deg C	0 to 300 deg C
Accessories for purging system	Purging system to be provided with heavy duty blowers and shutter mechanism for automatic isolation of lens during purge air failure.	Purging system to be provided with heavy duty blowers and shutter mechanism for automatic isolation of lens during purge air failure.	Purging system to be provided with heavy duty blowers and shutter mechanism for automatic isolation of lens during purge air failure.
Temperature compensation	Automatic temperature compensation to be provided	Automatic temperature compensation to be provided	Automatic temperature compensation to be provided

4.05.00 **Specific requirements for Particulate Emission (Dust density Stack Opacity) monitor**

Specification Requirements	**PARTICULATE EMISSION (Dust density Stack Opacity) monitor**
Type of Instrument	In-Situ dry type visible light (through LED) stack
Principle of Measurement	Transmission and absorption
Measurement Range	0 to 999mg/m2, (Programmable)
Accuracy	2% of FS
Linearity	+/- 1% of FS
Repeatability	≤ 1% of Span
Response time(up to 90% of full scale)	≤ 5 sec
a) Temperature Drift	+/-1% in 24 hrs
b) Zero Drift	< 1% span/week

c) Span Drift	< 1% measured value/week
Operating Temperature Range for probe	0-300 deg.C
Filter	To be provided
Accessories purging system	Purging system to be provided with heavy duty blowers and shutter mechanism for automatic isolation of lens during purge air failure.
Temperature compensation/measurement	Temperature compensation to be provided. Further, additional 4-20 ma signal for stack temperature through temperature transmitter shall be provided and connected to DDCMIS.

4.06.00 **Specific requirements for Continuous On-line Mercury Analyser**

S.NO.	PARAMETER	DETAILS
1	Measurement Principle	Atomic Absorption Spectrometry/ Atomic Fluorescence spectrometry.
2	Range	0-100 microgram/Nm3

4.07.00 **Specific requirements for O2 Analyzer cum monitor**

Specification Requirements	**Low Temp. O2 Analyser cum monitor**
Type of Instrument	Heated In-situ type
Principle of Measurement	Partial-pressure using Zirconium Oxide Cell
Measurement Range	0 to 25% oxygen programmable up to min 0.5% of O_2
Accuracy	+/-1% of Full scale
Linearity	+/- 1% of FS
Repeatability	≤ 0.5% of Span
Response time(up to 90% of full scale)	≤ 5 sec
a) Stability	-
b) Zero Drift	< 1% span/week
c) Span Drift	< 1% measured value/week
Process Temperature Range	0-450 deg.C
Filter/protection	Suitable filter to be provided
Accessories purging system	Not applicable
Temperature	Automatic temperature control of heating circuit through thermostat.
Probe Length	Approx. 2000 mm or 6 feet

4.08.00 **ULTRASONIC FLOW METER FOR FLUE GAS FLOW IN STACK**

Type	Transit time Ultrasonic meter
Mounting Style	Transducers on the duct/stack
Transducer type and material	Single pair of Corrosion resistant material to be provided
Zero and Span adjustment	To be provided
Flow measurement	Instantaneous Flow rate as well as totalized flow
Power supply Distribution	to be arranged by the Contractor from Employer's terminal point.
Outputs : Analog Datalink	 4-20 mA DC galvanically isolated. RS 232/RS485/Modbus protocol/ Ethernet TCP/IP protocol for bidirectional communication link with Employer's cloud server
Display/Indication	Flow meter with LCD screen backlight based local display and keypad . If required, transmitter shall be suitably located away from the sensor for better access and visibility.
Recording / Totalizing/Logging Facilities	To be provided
Diagnostics	False signal tolerance , power supply failure etc
Protection class	IP-65 or better
Ambient temperature	-20 deg to +60 deg C
Accuracy	<+/- 2%
Electrical connection	Plug and socket
Accessories	All mounting hardware required like clamping fixtures, mechanism to remove the transducers online, interconnecting cables to DDCMIS, cables, flexible conduits, junction boxes etc Purging arrangement for Cleaning sensors to be provided. Material of all fittings shall be SS 316.
Software features	Compensation for temperature and pressure and any cross path errors. Programming, configuration, shall be possible from front panel.

NOTES:-

01. Hot extractive sampling type/ Dilution extractive type systems shall be provided with dual sample probes along with all required accessories such as redundant heavy duty pumps with continuous rated motors, moisture detection facility, pre-fabricated heated (for sampling type only) sample lines from probes to analyser panel, solenoid valves, filters, coolers along with level switch in gas coolers for auto draining purpose and flow meter etc as applicable.

02. Not used

03. If the SOx, NOx, CO2 & CO (if sampling/dilution type) analyzers do not meet the environmental conditions specified at cl. 7.00.00 of Sub Sec IIIC-01, Section-VI, Part-B, panel AC shall be provided in analyzer cabinets to meet the requirement.

04. For O2 Analyser, the construction of the sensor shall be such that joints between dissimilar materials are avoided to prevent formation of cracks.

4.09.00 Connectivity with DDCMIS and provision for bidirectional communication with Employer's Cloud Server

1. 4-20mA signals from all the above analysers/flow meters/temperature transmitter to DCS of respective unit.

2. RS232/ RS485 Modbus protocol/ Ethernet TCIP/IP protocol for bidirectional communication with Employer's Cloud Server as defined in Sub-section-IIC-C&I/ Section-VI/ Part-A.

All the accessories and cables required for connecting Analysers outputs to DCS and provision of bidirectional communication as defined above shall be provided by Contractor on as required basis.

5.00.00 AMBIENT AIR QUALITY MONITORING STATION (AAQMS)

5.01.00 General Specifications for AAQMS

5.01.01 The Analysers / Monitors should be 19" Rack Mounted with the ON / OFF switch and display of all important status signals including Lamps, etc should be preferably on the front panel.

5.01.02 The system must function properly in the weather and atmospheric conditions mentioned in Sub-Section-IIIC-01, in view of ambient temperature, relative humidity and high dust levels for instruments / equipments housed in an enclosure.

5.01.03 The system should function without frequent servicing / maintenance. The parts requiring regular service / maintenance must be easily accessible.

5.01.04 All ambient Gas Analysers and Dust Monitor shall conform to the US EPA reference or equivalent method. A proof of approvals and certificates of the above compliance along with copy of the Test Report (in English) from internationally reputed agencies such as US EPA, TUV / UAB of Germany, Envt Canada, Envt. Japan, EEC etc shall be furnished.

5.01.05 All Analysers shall be micro-processor controlled with automatic calibration. All Analysers, Monitors and Sensors should be fully integrated in the 19" Rack Cabinet, fully calibrated and tested before supply.

5.01.06 The vendor shall provide warranty for the entire system. as defined elsewhere in the Contract.

5.01.07 NOT USED.

5.01.08 Vendor shall give complete list of spares, consumables etc. along with their costs required for trouble-free operation.

5.01.09 The system shall be supplied with all ancillaries and consumables necessary for trouble free operation during the Warranty period. In case self-life of any consumable is shorter, such supplies to be done in suitable phases. Vendor shall give details of self-life, quantity of consumables required etc. to last the warranty period.

5.01.10 O&M Manuals shall be supplied in line with the general requirement indicated in sub-section GTR indicating details of installation, operation and calibration; preventive, routine & corrective maintenance.

5.01.11 A Sampling System compatible with the Analysers / Monitors for Total Suspended Particulates (TSP), PM10 PM2.5, NOx, SOx, CO, Mercury and Ozone shall be provided by the vendor. The system, wherever applicable, shall also be compatible with Analysers for Pb (which the Employer may procure in future). The system, wherever applicable, shall have the facility for moisture removal.

5.01.12 Minimum requirements like power supply, space, building, ventilation & approach road required for installation and commissioning of the AAQMS shall be specified by the vendor in the offer. Vendor shall obtain statutory and other clearances for purchase, commissioning and operation & maintenance of the AAQMS.

5.01.13 Vendor shall furnish, along with the bid documents, the details of calibration system provided with each Analyzer / Monitor.

5.01.14 In addition to connection with respective local data logger and central data logger as defined in subsequent clauses, AAQMS analysers shall have provision for bidirectional connectivity with Employer's central cloud server as defined in Sub-section-IIC-C&I/ Section-VI/Part-A.

5.02.00 SPECIFICATIONS OF CONTINUOUS MONITORING AMBIENT AIR ANALYSERS

5.02.01 Oxides of Nitrogen (NO-NO2-NOX) Analyser

1.	Principle		Chemi-luminescence
2.	Measurement		NO, NO2, NOx in Ambient Air
3.	Display		LCD
4.	Ranges		0-1000 PPB in multi-ranges (minimum four selectable ranges) Preferably as below:
			0-100 PPB, 0-200 PPB, 0-500 PPB and 0-1000

			PPB
5.	Minimum Detectable Limit		1 PPB
6	Noise Level		0.5 PPB or less
7	Zero Drift at Lowest Range		<1PPB in 24 hours
8	Span Drift at Lowest Range		+ 2% in 7 days of full scale
9	Response Time at Lowest Range		2 minutes or less
10	Linearity		+ 1% of full scale
11	Calibration		Built-in Calibration Facility
12	Consumables and spares		Recommended requirements of 3 years of continuous operation
13	Digital Signal Transmission		RS 232 link. Analyser shall be capable to transfer all the data through RS 232 link to a PC based data logger.

5.02.02 Sulphur Dioxide (SO2) Analyser

1.	Principle		UV Fluorescence
2.	Measurement		Sulphur Dioxide in Ambient Air
3.	Display		LCD
4.	Ranges		0-1000 PPB in multi-ranges (Minimum four selectable ranges) Preferably as below:
5.			0-100 PPB, 0-200 PPB, 0-500 PPB and 0-1000 PPB
6.	Minimum Detectable Limit		1 PPB
7.	Noise Level		0.5 PPB or less
8.	Zero Drift at Lowest Range		<1PPB in 24 hours with automatic zero Compensation.
9.	Span Drift at Lowest		+ 2% in 7 days of full scale

	Range		
10.	Response Time at Lowest Range		2 minutes or less
11.	Linearity		+ 1% of full scale
12.	Calibration		Built-in Calibration Facility
13.	Consumables and spares		Recommended requirements of 3 years Continuous operation
14.	Digital Signal Transmission		RS 232 link. Analyser shall be capable to transfer all the data through RS 232 link to a PC based data logger.

5.02.03 NOT USED

5.02.04 Continuous ambient air measurement of TSP, PM 10 & PM 2.5

	Principle		The suspended Particulate Matter (SPM) Monitor for monitoring ambient air shall be based on the principle of beta attenuation by particulates sampled through the instrument and collected on movable filter tape. Before and after sampling, beta radiation shall be measured by appropriate counter. An internal microprocessor shall handle all sequences and automatically calculate the concentration of the particulate matter being measured. Contractor shall provide two nos SPM analysers in each AAQMS station for continuous measurement of suspended particulate matter. Each analyzer shall be designed for measurement of TSP, PM 10 & PM 2.5 so that any analyzer can be freely configurable at site for either TSP, PM 10 & PM 2.5. These analysers shall be provided with sampling heads suitable for continuous measuring of TSP and PM10. Additional sampling arrangement for PM 2.5 shall also be provided and it shall be possible to easily connect it to the Analyser normally measuring TSP.
	Measurement		Continuous ambient air measurement of TSP, PM10 & PM 2.5.
	Sampling System		System for sampling of particulates of following

			sizes
			(a) Total Suspended Particulates (TSP)
			(b) 10 microns or less.
			(c) 2.5 microns or less.
			The system shall have provision for removal of moisture from the sample, wherever applicable.
	Measurement Range		0-2000 microgram per cubic meter (microgram/m3) in programmable multi-ranges
	Display		LCD
	Resolution		1% of the concentration
	Minimum Detectable Limit		2 micrograms/m3
	Filter material		glass fiber filter
	Roll length		Approximately 30 meters
	Measurement result		1 hour average ~~of~~ or shorter
	Digital Signal Transmission		RS 232 link. Analyser shall be capable to transfer all the data through RS 232 link to a PC based data logger.

5.02.05 Multi-Gas Calibration System

To cross check the built-in-calibration facility of the Analysers/Monitors, a standard Multi-Gas Calibration System for each AAQMS station with fast response time shall be offered by the Vendor for SO2 and NOx (Vendor to give complete details thereof) which can be used as manual or remote multi-point generation of gas concentrations from one to several high concentration Span Gas Cylinders. The Multi-Gas Calibration System shall meet the US EPA or TUV/UAB of Germany, Envt Canada, Envt Japan, EEC etc. requirements.

5.02.06 Mercury Analyser

	Principle	Atomic Absorption/Atomic Fluorescence
	Measurement	Elemental Mercury in ambient air
	Display	LCD
	Range	0.5-2000ng/m3 / 5-10000 ng/m3 (selectable)
	Calibration	Built-in calibration facility

	Digital Signal Transmission	RS232 link. Analyser shall be capable to transfer all the data through RS 232 link to a PC based data logger.
	Accessories	To be provided

5.02.07 Ozone Analyser

1	Principle	UV Photometric / Chemiluminescence
2	Measurement	O3
3	Display	LCD
4	Ranges	0-100 ppb to 0-10 ppm.
5	Minimum detectable limit	0.6 ppb (RMS)
6	Zero drift	< 1.0 ppb
7	Span drift	+/-1% of measured value /week
8	Response time (upto 95% of full scale)	20 Seconds.
9	Linearity	1% of Full-Scale
10	Calibration	Built-in Calibration facility
11	Consumable and Spares	Recommended requirement of 3 year continuous operation
12	Digital signal transmission	RS 232 link. Analyser shall be capable to transfer all the data through RS 232 link to PC based Data logger.
13	Accessories	To be provided.

5.02.08 Carbon Monoxide (CO) Analyser

1	Principle		NDIR spectroscopy
	Measurement		CO
	Display		LCD
	Ranges		0-1 PPM to 0-1,000 PPM selectable.
	Minimum detectable limit		0.05 ppm

	Zero drift at lowest range		< 0.1 ppm/day
	Span drift at lowest range		< 1% of reading per day
	Response time at lowest range		<60 sec.
	Linearity		1% of Full-Scale
	Precision		0.5% of reading
	Calibration		Built-in Calibration facility
	Consumable and Spares		Recommended requirement of 3 year continuous operation
	Digital signal transmission		RS 232 link. Analyser shall be capable to transfer all the data through RS 232 link to PC based Data logger.

5.03.00 SPECIFICATIONS OF METEOROLOGICAL SENSORS

5.03.01 Specifications of Wind Speed Sensor

1.	Principle		Frequency proportional to wind speed
2.	Range		0-60 m/ sec
3.	Accuracy		2 % of full scale
4.	Threshold		0.3 m/ sec
5.	Operating Temperature		0 to 50 deg C

5.03.02 Specifications of Wind Direction Sensor

1.	Principle		Potentiometric type Sensor (Resistance proportional to Wind direction)
2.	Range		0-360 deg
3.	Accuracy		2 % of full scale
4.	Threshold		0.3 m/ sec
5.	Operating Temperature		0 to 50 deg C

5.03.03 Specifications of Air Temperature Sensor

1.	Principle		RTD (Platinum) Resistance proportional to temperature
2.	Range		0-50 deg C
3.	Accuracy		+ 0.2 deg C
4.	Operating Temperature		0 to 50 deg C
5.	Radiation Shield		Non-aspirated Radiation Shield

5.03.04 **Specifications of Relative Humidity (Rh) Sensor**

1.	Principle		Thin film capacitance type sensor
2.	Range		0-100% RH
3.	Accuracy		3 % for range 10% to 90%
4.	Sensitivity		0.2% RH
5.	Operating Temperature		0 to 50 deg C
6.	Radiation Shield		Non-aspirated Radiation Shield

5.03.05 **Specifications of Solar Radiation Sensor (Solarimeter)**

1.	Principle		Thermopile/Thermo couple based with Appropriate Wind Shield
2.	Range		0.3 to 60 microns
3.	Measurement Range		0-1500 watt/m2
4.	Accuracy		+ 3.5 %
5.	Operating Temperature		0 to 50 deg C

5.03.06 **Specifications of Rain Gauge**

Rain Gauge shall be of Self Recording Type and of reputed make & recording facility shall be provided in Electronics. The Gauge shall be rugged having material of construction resistant to atmospheric corrosion. The Instrument shall have automatic functions for computing rainfall for pre set time periods.

1.	Accuracy		+ 1 % to + 5% for rainfall rates Ranging from the lowest to 125 mm/hr or more
2.	Sensitivity		0.5 mm

3.	Operating Temperature		0 to 50 deg C

5.03.07 Meteorological Mast

One Meteorological Mast of telescopic type and of specified height to be placed on an structure (such as Buildings etc) so that height of the Meteorological Sensors from the Ground Level (GL) is 10 meters. The Mast is required for mounting the Meteorological Sensors. Necessary Hangers and Holders along with electrical Grounding Set shall be provided by the vendor for installation of the Sensors. Material of Construction of the Mast shall be metallic and robust and shall be resistant to atmospheric corrosion.

6.00.00 DATA LOGGER AT AAQMS & METEOROLOGICAL STATION

a) There shall be one PC based Data Logger for each AAQMS and Meteorological Station. The entire data capture and mean value calculation as well as control of Analyzers should be through user-.friendly software and operate on the latest Windows software system. Connection of Analyzers with serial Interface should be done through standard Connectors. Diagnostic features should be clearly indicated by the system and any unauthorized access should be protected by a pass word. PPB to micrograms per cubic meter (ug/m3) conversion factors should be part of the system.

b) The Data Logger shall be provided with at least 8 Analog and 24 Digital Inputs and internal memory for all collected parameters. The Data Logger shall have ability to log Channels at different intervals and should have capability of averaging and displaying real time data and averaged data over selectable periods (minutes, hours, days, months and years) such as 1 min, 10 min, ½ hr, 1 hr., 4 hrs., 8hrs., 24 hrs., 1 month, 3 months, 6 months, year etc. It shall have adequate capability of connecting to all Analysers/ Monitors including the optional Analysers and Sensors for meteorological parameters.

6.01.00 **Functional Requirements of Data Logger**

1. Calculate vector mean of wind direction and wind speed
2. Graphic & tabular display of the current air quality monitoring data.
3. Generation of Wind Roses, Pollution Roses etc.
4. Data reports, calibration reports and status reports for user selectable time period (instantaneous or averaged over a period of ½ hr, 1 hr, 4 hrs, 8 hrs, 24 hrs, weekly, monthly or yearly).
5. Control panel window for controls of each Analyser, including calibration.
6. Alarm for all parameters.
7. Real time multi-curves/graphs over user selectable time period.
8. Historic multi-curves/graphs over user selectable time period.

9. Real time status and diagnostics for maintenance people.

10. Programmable down loading of data.

11. Diurnal variation, standard deviation, regression and other statistical parameter reporting possibilities with various available models.

12. Possibility to export the data files in other formats.

6.02.00 Central Station for AAQMS

There shall be separate Data Logger for the Central Station having configuration similar to the individual AAQMS. Location of central station shall be in one of the unit control room.

6.03.00 Data Communication System for The Central Station

6.03.01 Data Communication system shall handle the data transmission of an ambient air quality network and receive incoming messages/ signals from remote Stations. The following additional features should be part of the system:

1. To collect all the data from the remote Stations at prescribed time or on request.

2. Manage at least 3 or more remote air quality-monitoring Stations.

3. Should have the remote control facilities for calibrations (Zero & Span) and Measuring Range.

4. Should display multiple Stations on-line data (momentary values) in tabular text and graphic format.

5. Should connect the remote stations through Wireless Communication link.

6.03.02 Additional features of the Data Logger at Central Station

1. Data Management, analysis and reporting

2. Latest Microsoft Windows operating System

3. 32 bit application

4. Data collection from remote stations via Data communication Server

5. Inter-comparison of data between monitoring stations

6. Comparison of data of various parameters for the same monitoring station.

7. Integrates charts, tables and graphics.

8. Should support primary and secondary mean values of user defined time interval.

9. Should have data backup facilities

10. Should have the facilities for calculation of Arithmetic mean values, average ½ hr, 1 hr, 2 hrs, 3 hrs, 4 hrs, 8 hrs, 12 hrs, 24 hrs, weekly monthly and yearly

11. Minimum, Median, percentile, Maximum, standard deviation frequency analysis and cumulative frequency analysis

12. Calculation of pollution load and Wind Roses

13. Reports of daily, weekly, annual and user defined period

14. Reports of Pollution load and Wind Roses, frequency analysis, and calibration

15. Should have the facilities of the following chart types:

    - Line & column chart
    - Simple 3 D, line & column chart
    - Polar diagram and 3 D perspective column chart

6.03.03 **Data Communication System**

Each AAQMS station shall be connected to Central data Acquisition station through a two way wireless communication link. This shall allow for wireless transmission of data periodically to individual and central DAS & do the necessary communication between stations. Bidders shall determine the optimal antenna type required to achieve data transfer rate between all wireless access points. Contractor shall use for this purpose, approved and standard equipment like antennas and/or amplification devices etc required to achieve the above and shall provide agreement of technical support and support availability.

Contractor shall obtain necessary approval for Licenses authorizing the use of communication equipment specified frequencies.

7.00.00 **VIBRATION MONITORING SYSTEM :**

Microprocessor based vibration monitoring system shall be provided for fan/pumps/motors etc. qty. of which shall be as indicated in Appendix I to Part A.

The Vibration Monitoring System shall be furnished on a system basis including, vibration transducers, phase marker sensor with low noise flexible cables in flexible conduit, terminated in local terminal boxes, necessary pre-amplifier/electronics mounted in local weather proof boxes, vibration monitors, mounting racks and cabinets etc. The vibration monitoring system shall include all power supplies, interconnecting cabling, calibration equipment, indicators, integrating units, signal conditioning devices and all other accessories, erection hardware required for monitoring of Vibration at each point. The contractor shall provide the vibration pads.

Contractor can offer up to Four Channel Vibration monitors. The allocation of channels shall be such that loss of one monitor shall not affect more than one side of the bearing of one machine. In the case of more than two channel Vibration monitors being provided by

the Contractor, then one spare monitor shall be provided mounted in the panel to take care of immediate replacement of any failed monitors. Offered vibration monitors shall be modular in construction, plug in type.

Eddy current / piezoelectric type transducers shall be used. The sensors shall be either proximity or velocity or accelerometer type. However, the finally selected sensor type shall also depend on recommendation of the equipment manufacturer & suitable for application requirement which shall be finalised during detail engineering and without any extra price. Transducers shall be furnished in weatherproof housing suitable for field conditions. Cables/cabling from transducers local JB to Vibration Monitoring system in Control Room/Control Equipment Room shall be provided by the Contractor.

Vibration monitoring system shall give one no. buffered output of 4-20 mA DC and two no. of buffered raw signal for each point monitored and one no. of buffered raw signal for each phase marker sensor. The 4-20mA signal shall be suitable for use as an input to DDCMIS, linear in proportion to vibration velocity or displacement. Raw buffered signal(s) shall be suitable for archiving and analysis. Monitor shall provide vibration indication calibrated in velocity units along with provisions of changing to displacement unit (field-programmable) for each measurement point in both horizontal & vertical planes. The generation of alarm and trip signals is not envisaged in vibration monitoring system , the same shall be derived in DDCMIS . However in case of vibration initiated protection of equipments , OEM standard and proven practices shall also be considered.

The Vibration monitor with power supplies shall be mounted in a separate self standing cabinet to be located in Control Equipment Room for the main plant auxiliaries and in respective offsite area control rooms for offsite auxiliaries as applicable. Contractor shall feed the vibration monitoring cabinet from redundant 24 V DC feeders from the respective 24 VDC chargers in the contractor's scope.

The power supply arrangement for monitors shall ensure that failure of one power supply shall not affect any monitoring function in the system. Also any power supply failure /earth fault in any of the monitors will be isolated without affecting other monitors/ common power supply. If 230 V AC UPS power supply is required for panel PC/ desktop PC, UPS/Mini UPS for the same shall be provided by the contractor.

The functional requirement for vibration monitoring system shall include but not be limited to the following:

- Vibration monitor front face status indications shall be available for indications of healthy conditions of pick up circuit, monitor circuit and power supply. On sensor fault/wire break in the sensor circuit, the system shall have the feature of identifying the same through suitable means like the signal forced to a value less than 4 mA. In case, such a feature is not available then suitable contact shall be provided from the monitor for sensor fault.
- The facility shall be available for online functional checking of monitors.
- All vibration monitoring equipment shall be functionally tested for circuit continuity and output response. All the components & interconnection cables shall be tested to ensure compliance with the specification requirements & all other applicable codes & standards.

All relevant functional requirements detailed above shall be met and the system shall be subject to Employer's approval.

8.00.00 SPECIFICATION FOR FLOW ELEMENTS

8.01.00 Orifice Plate

Features	Essential/Minimum Requirements
Type	Concentric as per ASME PTC-19.5 (Part-II), ISA RP-3.2, 1960 or BS-1042, ISO 5167
Material	316 SS
Thickness	3 mm for main pipe diameter up to 300 mm and6 mm for main pipe dia above300 mm.
Material of branch pipe	Same as main pipe
Root valve type	Globe
Root valve material	Same as pipe material
Root valve size	1 / 2 inch or 1 inch (as applicable)
Impulse pipe of same material up to root valve	Required
Tappings	Flanged weld neck or D & D/2 with 3 pairs of tapping (as applicable). Root valves to be provided in all the tappings.
Beta Ratio	0.34 to 0.7
Beta Ratio calculation to be submitted	Yes
Assembly drg. and flow Vs DP Curves	Yes
Accessories	Root valves, flanges, Vent/drain hole(As required)

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

8.02.00 Flow Nozzle

Features	Essential/Minimum Requirements
Type	Long radius, welded type as per ASME PTC-19.5 (Part-III) or BS-1042
Material	316 SS
Thickness	Suitable for intended application.
Material of branch pipe	Same as main pipe
Root valve type	Globe
Root valve material	Same as pipe material
Root valve size	1 inch

Impulse pipe of same material up to root valve	Required
Tapping	Flanged weld neck or D & D/2 with 3 pairs of tapping (as applicable). Root valves to be provided in all the tappings.
Beta Ratio	Around 0.7
Beta Ratio calculation to be submitted	Yes
Assembly drg. and flow Vs DP Curves	Yes
Accessories	Root valves, vent and drain hole.

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

9.00.00 SOLENOID VALVES

Solenoid valves shall fulfil the following requirements:

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

b. Power supply : 24 V DC ± 10%.

c. Plug and socket electrical connection.

d. Insulation : Class 'H'

10.00.00 WATER SYSTEM RELATED SPECIAL INSTRUMENTS (DM PLANT, CPU PLANT, PT PLANT, ETC., WASTE WATER TEARTEMENT PLANT, EFFULENT TREATMENT, AS APPLICABLE)

Contractor shall provide conforming to CPCB/SPCB guidelines following instruments shall be provided as per standard & proven PRACTICE: -Cation/Specific Conductivity, pH, Sodium, Silica, Turbidity, Total Dissolved Solids (TDS) and Concentration analysers,etc.

10.00.01 SPECIFICATIONS OF EFFLUENT QUALITY MONITORING SYSTEM (EQMS)

10.01.00 COMMON REQUIREMENTS FOR ALL ANALYSERS

Sno	Features	Minimum Requirement
1.	Output signals	Analog 4-20 mA DC galvanically isolated.
2.	Zero & span Adjustment	To be provided with range selection facility
3.	Ambient temp	50 degC
4.	Sample Temperature	40 degC
5.	Indication	Digital Alphanumeric Display of reading in

		engineering units shall be provided.
6.	Type of Electronics	Microprocessor based with self-diagnostic
7.	Calibration	Manual
8.	Others	All interconnection tubing and cabling between sensor and analyzer / analyzer panel etc to be provided. All chemical reagents required for EQMS analyzers for entire O&M period is to be supplied in phased manner depending on shelf life.
9.	Location of the Temp & flow measurement	Effluent Treatment plant outlet (Exact location to be decided by contractor in consultation with site)
10.	Location of the Analyser cabinet/enclosure	
11.	Accessories	All the accessories required for mounting the sensor/analyser are to be provided
12.	Digital Signal Transmission	Each analyser shall have a provision for bidirectional soft connectivity over Modbus/RS232/RS485 with employer's central cloud server in addition to 4-20 ma connectivity to DDCMIS.
13.	Compliance to standards	CPCB's (Central Pollution control Board) latest regulatory requirement prevailing at the time of execution of the contract.

10.02.00 CONDUCTIVITY ANALYSER

Type	Continuous flow through type
Measuring Range	0 – 60000 µS/cm for sea water application 0-5000 µS/cm for other application
Response Time	<= 5 sec (90% of full scale)
Temperature Compensation	Automatic
Power	To be arranged by the contractor
Accuracy	<= +/- 1 %

10.03.00 pH ANALYSER

Type	Cell flow through sample
Measuring Range	0-14 units of pH
Temperature Compensation	Automatic
Power	To be arranged by the contractor.
Accuracy	<= +/- 1 %

10.04.00 BOD BIOLOGICAL OXYGEN DEMAND / COD CHEMICAL OXYGEN DEMAND ANALYSER

Principle	COD/BOD measurement by: Option A. Total Organic Carbon (TOC) measurement complying to US EPA 415.1 / 415.2 or equivalent standard for effluent/sewage/waste water. Option B. UV-VIS spectrometer measuring absorption in UV-VIS spectrum.
Measuring Range	0-50 mg/L for BOD, 0-500 mg/L for COD
Response Time	<= 15 min
Power	To be arranged by contractor
Cleaning	Self-cleaning (Automatic)
Accuracy	+/- 3%

10.**05.00** **OIL IN WATER ANALYSER**

Principle	UV Fluorescence
Measuring Range	0 to 30 mg/l
Response Time	<= 60 sec
Power	To be arranged by the contractor.
Cleaning	Self-cleaning (Automatic)
Accuracy	+/- 5 % of full scale

10.06.00 **TOTAL SUSPENDED SOLIDS – TSS ANALYSER**

Principle	Light reflection principle
Measuring Range	0-500 mg/l
Response Time	<= 5 min
Power	To be arranged by bidder (Refer terminal point)
Cleaning	Self-cleaning (Automatic)
Accuracy	+/- 5%

10.07.00 **ENCLOSURE/CABINETS / PANELS**

The enclosure shall accommodate all EQMS Analyser. The enclosure shall provide protection from dust, humidity, precipitations, sunlight and environmental pollution. The material for the enclosure shall be of steel plate with minimum 2 mm thick frame and 1.6 mm thick CRCA steel sheet of protection IP 55 or better with safety lock of good quality. The lighting provision in the cabinet and the canopy for the cabinet is to be provided. The cabinets shall be designed such that the wet section and dry section are separate, the exact details shall be finalized during detailed engineering.

In order to ensure the healthy operation of the installed electronic modules, cards, analyzers, etc inside the enclosure during continuous operation, the EQMS enclosure shall be provided with Air conditioner unit .

SUB–SECTION – IIIC – 04

SPECIAL INSTRUMENTS

CONTROL AND INSTRUMENTATION SYSTEM

1.00.00 SPECIAL INSTRUMENTS

1.01.**00** **WASTE WEIGH MEASUREMENT BRIDGE:-**

Contractor shall provide a weigh bridge at entry & exit of the Waste transporting Vehicles. Load cell based measurement system along with facility to count incoming & outgoing vehicles. The weigh bridge shall be supported minimum 4 no's compression type load cells mounted on free motion structural Unit. The minimum accuracy of 1% of the gross weight of the vehicle.
The weigh measurement system shall be integrated with DDCMIS system at Central control Room.

1.02.00 **Waste Crane weigh measurement system:--**

Necessary weigh measurements during lifting of waste from waste pit is to be provided with minimum accuracy as per industry standards and this measurement shall be integrated with DDCMIS.

1.03.00 **FLAME MONITORING 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 GAS shall be reduced to optimal minimum.

Fail Safe, easily maintainable Flame Monitoring System 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 Boiler manufacturer. The Contractor shall furnish the justification of selection of flame detector locations for Employers 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. Flame Intensity and Flame fault signal from scanner shall be wired up to SG-DDCMIS.

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

The Contractor shall demonstrate the complete performance of flame detectors in cold start up test and load condition test. In cold start up test, capability of detectors to detect gas flame under varying gas pressure shall be checked. In load test, the detector shall be able to detect when only GAS is present.

Provision of scanner air for cooling the flame detectors may be done as per bidder standard practice and requirement as per scanner manufacturer

1.04.0 GRAM FEEDERS CONTROL AND INSTRUMENTATION

Contractor shall provide a microprocessor based Waste Feeder C&I system having the following feature. It is preferable to use the same family of hardware as that of CLCS for implementation. Bidder's standard and proven practice shall also be considered subject to Employer's approval during detailed engineering

Necessary instrumentation & control shall be provided to hook up with DDCMIS for smooth operation of the plant.

1.05.0 ACOUSTIC PYROMETERS

Acoustic Pyrometers are to be provided to determine the average flue gas temperatures and complete flue gas temperature profile Furnace Exit plane (for FEGT measurements) and at Economizer outlet.

For each temperature measurement plan/section, A PC based system complete with all required software, comprising of minimum eight nos. of acoustic transreceivers, signal processor, interface unit, PC & Colour Inkjet Printer (Common for one unit) shall be provided. The specification of the Windows based PC shall be as per the standard and proven practice of OEM/OES of Acoustic Pyrometer. The system shall be able to eliminate the varying high noise environment both in and out of an operating boiler.

The measuring range should be sufficient to cover the entire regime of boiler operation and shall not be less than 1900°C. The mean temperature and profile temperature accuracy shall be ± 2%, & ± 4% of reading respectively or better. Full colour VDU display and colour printer output shall be provided. The system shall also provide 4-20mA DC output for Unit DDCMIS.

The transit time of each of the associated transmitters/receivers shall be transmitted to the central processing unit (to be located at CER) for storage and analysis through suitable interface device. A temperature profile shall then be determined and displayed by analyzing the mean temperature across every transit section using deconvolution technique. The time interval to make a complete cycle of eight transceivers should be less than one minute.

The transducers shall not be placed directly in the hot gas stream. The system shall be of proven design and it's performance must be proven for similar boilers using similar type of fuel . The components to be located at Boiler Area shall be able to withstand the stringent environmental condition expected at such locations with operating Boiler.

In case it is the standard practice of the vendor is to supply acoustic pyrometer with separate transmitter and receiver, then the same is also acceptable subject to the condition that the configuration to be selected shall provide the same number of transit paths remains the same as with the trans receiver system specified above.

1.06.0 FURNACE AND FLAME VIEWING SYSTEM

Bidder shall include in his proposal a Furnace and flame viewing system. The flame cameras shall be suitable for direct online continuous viewing in the central control room of the waste flame & gas flame and condition of the furnace internals and any other deterioration in the furnace condition. The nos. and type of such flame cameras to be included in the proposal shall be selected by the contractor appropriate to his boiler design,

however, minimum two numbers of cameras shall be provided. Separate set of cameras shall be provided for viewing flame and furnace internals based on proven technology for the intended application.

The camera system will consist of the following facilities/ components as a minimum:

(a) One number **40" High resolution, Industrial grade wall mounted LCD panel (**For displaying both camera images in single screen through DVR with recording facility. The DVR shall have spare capacity to connect at least two more cameras online).

(b) Facility for zooming and adjustment of iris from the monitor for view of furnace internals.

(c) Proper cooling arrangement (Instrument air) with two stage filters and protection against cooling medium failure.

(d) Weatherproof local control box for mounting of electronics.

(e) All necessary remote/ local programming tool.

(f) All interconnecting cable and termination device including cable required for LVS connection**.**

(g) Any other accessory to make the system completely operational

(h) All necessary software.

The cameras and the total system shall be suitable for the furnace design as being offered by the main boiler vendor, the firing arrangement (corner, front/ wall fired), the fuel being fired considering the ash content of worst coal. The cameras should be expected to withstand the temperature expected in the furnace of the offered boiler but shall not be less than 1900 deg C.

The viewing angle of the camera shall be commensurate with the furnace size, the camera location and the positioning of the burners. The system shall conform to PAL and number of TV lines shall be adequate for a clear image of the furnace

The offered flame camera system shall have a record of trouble free performance in a coal-fired boiler.
The system shall be connected to the large video screen (LVS) for transmitting the images.
Following minimum controls shall be provided in suitable Box mounted on the operator Desk in the CCR:
a) Iris control,
b) zoom control,
c) Advance/ retract/ reset.

Following minimum status shall be displayed on the same control box.
a) Advanced/ retracted
b) Fault.

2.01.00 **TURBINE SUPERVISORY SYSTEM (TSS) & VIBRATION FOR EQUIPEMENTS**

2.01.01 **TURBINE SUPERVISORY INSTRUMENTS (TSI)**

1	The turbine supervisory equipment shall be complete including sensors, transmitters, converters, limit value monitors, measuring and amplifier modules, power supplies etc. with the required accessories including twisted and shielded instrumentation cables, compensating cables, junction boxes etc.

2	*Following measurements are envisaged to be provided by the* Contractor *for supervisory purpose. Based on* Manufacturer's *standard and proven practice, the* Contractor *shall clearly identify the applicable measurements for his equipments as applicable, optional and not-applicable-non optional in the Bid.* Contractor *shall include all the applicable and optional items in his scope of work.*	
	(a)	Shaft eccentricity detection.
	(b)	Relative shaft vibration measurement, of each bearing in both X & Y direction (both for Turbine and Generator bearing).
	(c)	Differential expansion of rotor and turbine cylinder.
	(d)	Overall expansion.
	(e)	Bearing vibration measurement of each bearing in both X & Y directions (both for turbine and generator bearings).
	(g)	Axial shift of the rotor, (minimum three sensors).
	(l)	Phase marker with associated notch on shaft shall also be provided for zero speed detections and /or vibration analysis system defined below.
	(m)	Any other measurement recommended by the Turbine manufacturer as required for the safe and reliable operation.
3	The system shall be provided with suitable hardware for necessary signal processing. The system should be capable of signal distribution and interfacing with DDCMIS.	
5	Test calibration jigs for site calibration of all sensors of TSS shall be provided	

ALL HT drives (pump/Fans) shall be provided with vibration measurement (x&y) at each Motor & FAN/Pump bearing.

For all above measurements 4-20 mA output signals shall be provided to integrate with DDCMIS system being provided by Contractor.

2.02.00 **SPEED MEASUREMENT FOR TURBINE SYSTEM**:-

Minimum Three numbers of speed sensors shall be provided for measurement of turbine speed .the output of same shall be integrated with DDCMIS system being provided by Contractor.

2.03.00 LOAD TRANSDUCERS

The specification of load transducers shall be as per standard and proven practice meeting the process requirements.

2.03.00 **AUTO-SYNCHRONIZER FOR TURBO-GENERATOR INCLUDING TEST KIT**

2.03.01	The specification of Auto Synchronizer including Test kit for Auto synchronizer shall be as per standard and proven practice of Contractor/ manufacturer meeting the process and electrical system requirements. Auto synchronizer test kit is the simulation kit required for complete functionality checks including sourcing of incoming & running voltages with varying frequency & magnitude in OFF-LINE mode.

SUB–SECTION – IIIC - 05

ELECTRICAL POWER SUPPLY SYSTEM

ELECTRICAL POWER SUPPLY SYSTEM

1.00.00 ELECTRICAL POWER SUPPLY

1.01.00 The requirements of Electrical Power Supply system are specified herein on system basis. The Contractor shall be responsible for engineering and furnishing a complete and operational system fully meeting the intent and requirements of this specification including tender drawings and Employer approved drawings during detailed engineering. All equipment and accessories required for completeness of this system shall be furnished by the Contractor 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 as per the requirements of this specification at the manufacturer's works.

1.02.00 The power supply system shall be designed to meet the electrical power requirements of C&I systems including DDCMIS. The Power Supply System shall be designed to give the voltage at approximate mid level of the tolerance band of the power supply modules/packs of Control System, when the charger is feeding the load. This shall also take in consideration the voltage drop in cables from DCDB to the control panels. In case the Power Supply Output of a charger exceeds the voltage band tolerated by the power supply modules/packs of Control System, provision for safe tripping of that charger is to be ensured.

1.03.00 The DC Power Supply for various sub-systems shall consist of one or more of the following configurations. The applicable configurations are as indicated in Appendix-1 to Part-A of contract quantities: -

(B1) DC power supply system for UNIT (BOP) Area: DC power supply system shall comprise of two sets. Each set shall consist of 1 x 100% microprocessor controlled, intelligent, modular rectifier banks, Controller –one for each rectifier bank, 1 x 100% batteries for one (1) hour duty, 1 X 100% DC distribution board.

Contractor has the option of supplying either Nickel Cadmium type batteries or Lead Acid Plante type batteries for this configuration.

The specifications for this DC Power Supply System shall be as per Cl.No.2.01.00 to 2.03.00 and specifications for Battery shall be as per Cl. No 4.00.00 for Ni-Cd type Batteries & 5.00.00 for Lead Acid Plante type Batteries.

(B2) DC power supply system for areas other than Unit (BOP) : DC power supply system shall comprise of two sets. Each set shall consist of 1 x 100% microprocessor controlled, intelligent, modular rectifier banks, Controller –one for each rectifier bank, 1 x 100% Nickel - Cadmium batteries for one (1) hour duty, 1 X 100% DC distribution board.

The specifications for this DC Power Supply System shall be as per Cl.No.2.01.00 to 2.03.00 and specifications for Battery shall be as per Cl. No 4.00.00 for Ni-Cd type Batteries

Bidder shall clearly bring out in the proposal the redundancy features along with configuration diagram, single line diagram & data sheets etc. and this shall be finalized and subject to Employer's approval during detailed engineering.

1.04.00 NOT USED.

1.05.00 The UPS Power Supply for various sub-systems shall consist of one or more of the following configurations. The applicable configurations are as indicated in Appendix-1 to Part-A of contract quantities.

Bidder shall clearly bring out in the proposal the redundancy feature along with configuration diagram, single line diagram and data sheets etc. & this shall be finalized subject to employer's approval during detailed engineering.

(A) UPS System shall consist of 2 x 100% parallel redundant chargers and inverters with input isolation transformers, 1 x 100% battery bank for one (1) hour, Bypass line transformers & voltage stabilizer, static switch manual bypass switch, 2 x 100% ACDB, 1x100% Microprocessor controlled Battery Health Monitoring System (BHMS) and other necessary protective devices and accessories.

Contractor has the option of supplying either Nickel Cadmium type batteries or Lead Acid Plante type batteries for this configuration.

The specifications for this UPS configuration shall be as per Cl.No.3.00.00 to 3.05.00 and specifications for Battery shall be as per Cl. No 4.00.00 for Ni-Cd type Batteries & 5.00.00 for Lead Acid Plante type Batteries.

1.06.00 For distribution of UPS Supply, Contractor shall provide clean suitable power distribution as required for smooth operation of plant as per standard practice.

2.00.00 DC POWER SUPPLY SYSTEM (24 V),

2.01.00 Microprocessor based, Intelligent, Modular Power Supply

The minimum capacity of the modular power supply inclusive of 10% design margin shall be as indicated in Appendix-I to Part A of the specification.

2.01.01 Microprocessor based, Intelligent, Modular Power Supply shall be sized for continuous duty to meet 100% load requirements and keep the connected battery fully charged in float mode. The minimum capacity inclusive of 10% design margin shall be as indicated in Appendix-1 to contract quantity Part-A of the specification. Either of the bank of rectifier modules shall be able to re-charge the fully discharged battery within 8 hours. It shall also be possible to discharge batteries periodically manually. Each rectifier bank shall be provided with N+1 rectifier modules and the maximum numbers of rectifier modules shall not be more than 25 Nos. However, the exact number of rectifier modules shall be as finalized by the Employer during Detailed Engineering. The exact sizing of the rectifiers in one bank shall be subject to Employer approval during detailed engineering. It shall be ensured that all rectifier modules in one rectifier bank shall be of same rating and not more than three ratings of rectifier modules shall be used in various rectifier banks. Provision for manual boost charging with isolation of loads shall be provided.. While sizing, the temperature derating factor as applicable, is to be considered for arriving at the rating of the modules as per Bidder's manufacturing standard if the modules are rated for lower than the 50 deg. C ambient. For the rectifier bank, matching controller along with applicable software shall be provided to meet system requirements under all modes of operation."

2.01.02 The rectifier module shall be microprocessor controlled, IGBT/ Power MOSFET based, high frequency with active load sharing, designed for single and parallel operation with battery and shall have automatic voltage regulators for a close voltage stability even when AC supply voltage and DC load fluctuates, effective current limiting features, front access design, programmable temperature compensation feature for battery charging and filters on both input and output to minimise harmonics. The rectifier module output regulation shall be ± 1%

or better from no load to full load with an input power supply variation of ± 10% in voltage and ± 5% in frequency. In addition to indications/display on charger panel, alarms shall also be provided by employing RS 485 Port Modbus Protocol / Ethernet TCP/IP protocol for use in DDCMIS. Further isolated 4-20 mA signals shall be provided for important parameters like rectifier bank voltage, rectifier bank current, battery voltage, battery current, DCDB Voltage, DCDB current etc. The list of alarm output & 4-20 mA signals shall be as approved by Employer during detailed engineering. Necessary provision shall be done in DDCMIS end also.

2.01.03 The rectifier module shall be fed from 415V AC, 50 HZ, 3 phase, 3 wire system.

2.01.04 "Float/Boost" charge functions shall be provided with alarm/indications.

2.01.05 The rectifier module circuitry shall be of fail-safe design and failure of any component should not result in any rectifier bank output voltage to increase beyond acceptable limits of the C&I system being fed from it.

2.01.06 The rectifier module shall be current limited for circuit protection and protection of battery from overcharge. The current limit shall be continuously programmable.

2.01.07 The rectifier module shall have a slow walk-in circuit which shall prevent application of full load DC current in less than 10 seconds after AC power is energised.

2.01.08 The full load efficiency of rectifier module at nominal input and output shall be at least 90%. The ripple content shall be limited to +/- 0.5 % of output voltage.

2.01.09 The Controller shall be microprocessor controlled for monitoring & control of rectifier modules with features viz. Auto/Manual battery discharge test, battery reserve time prediction, energy management, float/boost mode control etc.

2.01.10 All Software as required for smooth operation and monitoring of rectifier modules in conjunction with Controller & BHMS shall be provided by the Contractor.

2.01.11 Contractor shall furnish the equipment complete in all respects along with rectifier module rating & voltage drop calculations, supporting curves/data etc.

2.02.00 **DC Distribution Board (DCDB)**

Redundant DC feeders (one from each DCDB) shall supply each of the connected loads. The exact design, rating & number of feeders of the each redundant DCDB shall be as finalised during detailed engineering and as approved by Employer. However, 25% spare feeders (min. 1 no.) with MCB and fuses for each rating shall be provided in each DCDB.

3.00.00 UNINTERRUPTIBLE POWER SUPPLY (UPS) SYSTEM

The minimum capacity of the UPS at load factor of 0.8 lagging inclusive of 10% design margin at 50 deg c shall be as indicated in Appendix-I to Part-A of the specification.

The UPS system shall meet the following requirements as a minimum.

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 overload 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, limited to 8 percent of finally selected ups capacity.

3.01.00 **Chargers**

3.01.01 The chargers shall be self regulating, solid state silicon controlled, full-wave rectifier type designed for single and parallel operation with battery and shall have automatic voltage regulators for close voltage stability even when AC supply voltage fluctuates, effective current limiting features and filters to minimise harmonics. The charger should be capable to fully charge the required batteries as well as supply the full rated load through inverter. Furthermore the charger should be able to re-charge the fully discharged battery within 8 hours. The charger output regulation shall be ± 1% from no load to full load with an input power supply variation of ± 10% in voltage and ± 5% in frequency. In addition to indications/display on charger panel, alarms along with relevant analog measurements shall also be provided by employing RS 485 Port Modbus Protocol / Ethernet TCP/IP protocol for use in DDCMIS. The list of alarm output & 4-20 mA signals shall be as approved by Employer during detailed engineering.

3.01.02 The charger shall be current limited for charger circuit protection and protection of battery from overcharge shall also be provided. The current limit shall be continuously adjustable. The chargers shall have a slow walk-in circuit which shall prevent application of full load DC current in less than 10 seconds after AC power is energised.

3.01.03 The chargers shall be fed from 415V AC, 50 HZ, 3 phase, 3 wire system. Charger design shall ensure that there is no component failure due to fluctuations of input supply or loss of supply and restoration.

3.01.04 The minimum full load efficiency at nominal input and output shall be 90%. The ripple content shall be limited to +/- 2 % of Charger output voltage.

3.01.05 The UPS battery shall have sufficient amp-hour capacity to supply the steady state KVA rating of the UPS specified for 60 minute, irrespective of the actual load on UPS.

3.01.06 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 guaranteed without the battery in circuit.

3.01.07 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.

3.02.00 **Static Inverters**

The static inverter shall be of continuous duty, solid state type using proven Pulse Width Modulation (PWM)/Quasi square wave/step wave technique. Ferro-resonant types Inverters are not acceptable. The nominal voltage output shall be 230 Volts. single phase ,50 Hz. 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 ± 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 synchronisation limit for maintenance of synchronisation between the inverter and stand by AC source shall be 48-52Hz, field adjustable in steps of 1 Hz.

3.03.00 **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 healthy inverter in case of failure of one of the two inverters and (ii) from faulty inverter to standby AC source in case of failure of both the inverters. The transfer time shall be ¼ cycle maximum in synchronous mode.

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

Continuous and overload capacity of the switches shall be equal to 100% of the continuous and overload rating of each inverter. Peak Capacity shall be 1000% of continuous rating for 5 cycles.

3.04.00 **Step Down Transformer and Voltage Stabiliser**

One 415V three phase to 230V, single phase transformer along with associated voltage stablizer shall be furnished with each UPS system. The transformer and stablizer combination shall convert Employer furnished 415V ± 10% three phase plant auxiliary AC supply to 230 V ± 2%, single phase standby AC Power Supply source.

The transformer shall be of low impedance air-cooled type and its KVA rating and percentage impedance should be selected so that extremely fast fault clearance is achieved.

The overload capacity of the transformer and voltage stabilizer shall not be less than 300% for 200 millisecond duration. The voltage stabilizer shall employ servo-controlled circuitry and shall maintain the specified output voltage for 0-100% load with maximum input voltage variations as indicated above. The efficiency of the stabiliser shall be 95% or better.

The type and other details shall be subject to Employer's approval.

3.05.00 **AC Distribution Board (ACDB)**

The details of the AC distribution board, i.e. exact, rating and number of feeders etc. of the 2x100% ACDB shall be as indicated in Appendix-1 to contract quantity, Part-A of the specification and as approved by Employer during detailed engineering . ACDB shall be designed to cater to the requirements of both Employer's System and Contractors systems.

4.00.00 **Batteries**

4.01.00 Nickel Cadmium Batteries

4.01.01 The batteries shall be heavy duty Nickel-cadmium type and shall be sized for one hour of full load operation during non-availability of AC supply / chargers. The Ni-Cd batteries shall **strictly** conform to the latest edition of **IS: 10918** including all applicable official amendments and revisions as on date of opening of techno-commercial bid. For sizing calculation, an aging factor of 0.8 and a temperature correction factor as per manufacturer's standard at 4 deg. C electrolyte temperature (Based on temperature characteristics curve to be submitted by the Contractor at a temperature of 4 deg. C), Capacity factor, float correction (if applicable) shall be taken into consideration. The sizing of the battery shall be as approved

by Employer during detailed engineering. The Contractor shall typically consider a voltage drop of 2.5V from battery room to DCDB and DCDB to load, while sizing the battery for 24 V DC Charger System and 4V from battery room to the inverter input while sizing the battery for UPS System.

4.02.04 **GENERAL TECHNICAL REQUIREMENTS**

4.02.04.01 Equipments

DC Batteries shall be stationary lead acid Plante positive plate type conforming to IS:1652. The battery shall be high discharge performance type shall be sized for one hour of full load operation during non-availability of AC supply / chargers. For the purpose of sizing Temperature Correction Factor as per manufacturer's standard at 4 Deg C electrolyte temperature, relative humidity of 95%, aging factor of 0.8 and Capacity Factor shall be considered. The Contractor shall furnish relevant charts, curves, tables etc. in support of the various factors considered during battery sizing. The batteries shall be boost charged at about 2.7 volts per cell maximum and float charged at about 2.25 V/cell

The number of cells for the 24 V DC Charger System and UPS System shall be decided during detailed engineering. Connectors & fasteners shall be used for battery cell connections and each cell be identified with manufacturer AH capacity, manufacturer name ,etc.

5**.00.00** **CABINETS / ENCLOSURES / POWER DISTRIBUTION BOXES**

The Construction details for Power Supply System Cabinets/ Enclosure/Racks shall conform to the requirements for indoor mounted cabinets & designed such a way that temperature rise inside the panel shall not exceed 10 Deg C above ambient temperature.

6**.00.00** **COOLING SYSTEM**

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

Reserve cooling equipment shall be furnished for each assembly. Reserve fan(s) 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. Each cooling fan system shall alarm on failure of airflow or rise in temperature. The fan power supply shall be finalized during detail engineering.

SUB–SECTION – IIIC - 06

PROCESS CONNECTION

AND PIPING

PROCESS CONNECTION AND PIPING

1.00.00 **PROCESS CONNECTION PIPING**

1.01.00 The Contractor shall provide, install and test all required material for completeness of Impulse Piping System and Air Piping System as per the requirements of this Sub-Section on as required basis for the connection of all instruments and control equipments of entire plant.

1.01.01 **IMPULSE PIPING, TUBING, FITTINGS, VALVES AND VALVE MANIFOLDS**

1.01.02 All impulse pipes shall be of seamless type conforming to ANSI B36.10 for schedule numbers. The size of impulse pipe shall be ½" for Steam & Water Application and ¾" for Air & Flue Gas applications. The rating of material of impulse pipes, tubes, fittings, valves and their installation thereof shall conform to the latest edition of standards as per following table:

Impulse Pipes, Tubes (Material, Rating)	ANSI B31.1, ANSI B31.1a, ANSI/ISA 77.70
Valves (Material, Pr. Class, Size)	ASTM A182/ASTM A105 as per ASME 16.34
Fittings (Size, Rating, Material)	ANSI B31.1, ANSI B31.1a, ASME B16.11-2009
Installation Schemes	BS 6739-2009, ANSI/ISA 77.70

Stainless steel tube shall be provided inside enclosures & racks from tee connection to valve manifold and then to instrument. 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. Two root valves are to be used wherever pressure is more than 40 Kg/cm^2 or Temp>280 ^{o}C. The end connections of valves shall be of socket welded type.

1.01.03 The valve manifolds of 316 SS with pressure rating suitable for intended application shall be provided as given below:

Manifold	Application/Measurement
2 Valve	Pressure measurements using pressure transmitters/pressure switches
3 Valve	Pressure measurements using differential pressure transmitter/ switches
5 Valve	Differential Pressure, Flow and Level Measurements

For Pr./D.P gauges, two-way globe/gate valve shall be provided on each impulse line to the instrument in Fluid/Air & Flue Gas applications respectively .

AIR SUPPLY PIPING

1.01.04 All pneumatic piping, fittings, valves, air filter cum regulator, purge rotameter 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.

2.03.00 The Contractor shall also provide SS Tubing and associated fittings (screwed type) of suitable sizes for all pneumatic equipments/actuators (including supply air, signal air and output to actuators) conforming to ANSI 31.1 and 31.3 standard. All other air supply lines shall be of mild steel hot dipped galvanized inside and outside as per IS-1239, heavy duty with threaded ends. Fittings for air supply line 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. Air supply piping shall be adequately sloped to prevent accumulation of condensed water within the pipe. The air supply headers, sub-headers and branch pipes shall be supported properly by clamps or supports.

2.04.00
2.05.00 All the isolation valves in the air supply line shall be gate valves as per ASTM B62 inside screw rising stem, screwed female ends as per ASA B2.1. Valve bonnet shall be union type & trim material shall be stainless steel, body rating 150 pounds ASA. The valve sizes shall be ½ inch to 2 inch.

2.06.00 Instrument air filters cum regulator set with mounting accessories shall be provided for pneumatic device requiring air supply. The filter regulators shall be suitable for 10-kg/ sq.cm max. Inlet pressure. The filter shall be of size 5 microns and of material sintered bronze. The air set shall have 2-inch size pressure gauge and built in filter housing blowdown valve. The end connection shall be as per the requirement to be finalized during detailed engineering.

2.00.00 **INSTALLATION AND ROUTING**

2.01.01 All instrument piping, tubing and its accessories shall be supported in a safe manner to prevent excessive vibrations and anchored sufficiently to prevent undue strain on connected equipment. Impulse piping shall be supported at an interval not exceeding 1.5 meters. The slope of the impulse pipe form the process connection to the instrument shall be as per ANSI/ISA 77.70 latest edition and BS 6739-2009. All impulse piping shall be installed to permit free movement due to thermal expansion. Wherever required expansion loops shall be provided.

SUB–SECTION – IIIC-07

INSTRUMENTATION AND POWER SUPPLY CABLES

1.00.00 **INSTRUMENTATION CABLE, CONTROL & POWER SUPPLY CABLE, INTERNAL WIRING AND ELECTRICAL FIELD CONSTRUCTION MATERIAL (CABLE SUB-TRAYs ETC)**

1.01.00 **General requirements**

1.01.01 All cables including special cables, internal wiring and electrical field construction material shall conform to this specification, Employer approved detail engineering drawings & documents and the latest edition of the relevant standards & guidelines. The Bidder shall furnish all material and services required for the completeness of the work identified in his scope as per this specification.

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

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

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

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

2.00.00 **SPECIFICATION OF INSTRUMENTATION CABLE**

2.01.00 **Common Requirements**

S. No.	Property	Requirement
1	Operating Voltage	225 V (peak value)
2.	Codes and standard	All instrumentation cables 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) and their amendments read along with this specification.
3.	Continuous operation suitability	At 205 Deg C for Type-C cables & heat resistant cables, at 70 Deg C for all other type of cables.
4.	Marking :- a.*Progressive automatic on-line sequential marking of length in meters to be provided at every one meter on outer sheath.* *b.*Marking to read 'FRLS' to be provided at every 5 meters on outer sheath except for Type-C cable c.Durable marking at intervals not exceeding 625 mm shall include manufacturer's name, insulation material, conductor's size, number of pairs, voltage rating, type of cable, year of manufacturer to be provided on outer sheath.	

S. No.	Property	Requirement
5.	Allowable Tolerance on overall diameter	+/- 2 mm (maximum) over the declared value in data sheet
6.	Variation in diameter	Not more than 1.0 mm throughout the length of cable.
7.	Ovality at any cross-section	Not more than 1.0 mm
8.	CAGE-CLAMP suitability	To be provided
9.	Color	The outer sheath shall be of blue color.
10.	Others	Repaired cables shall not be acceptable.

2.02.00 **Specific Requirements**

Specification Requirements	Type-A cable	Type-B cable	Type F & G cable	Type-C cable
A. CONDUCTORS				
Cross section area	0.5 sq. mm			
Conductor material	ANSI type KX	ANSI type SX	Annealed bare copper	ANSI type KX
Colour code	Yellow-Red	Black-Red	As per VDE-815	Yellow-Red
Conductor Grade	As per ANSI MC 96.1		Electrolytic	As per ANSI MC 96.1
No & dia of strands	7x0.3 mm (nom)			
No. of Pairs	2	2	2/4/8/12/16/24 / 48	2
Max. conductor loop resistance per Km (in ohm) at 20 deg. C	As per ANSI MC 96.1		73.4	As per ANSI MC 96.1
Reference Standard	As per ANSI MC 96.1		VDE : 0815	As per ANSI MC 96.1
B. INSULATION				

Specification Requirements	Type-A cable	Type-B cable	Type F & G cable	Type-C cable
Material	Extruded PVC type YI 3			Teflon (i.e. extruded FEP)
Thickness in mm (Min/Max)	0.25/0.35			0.4 / 0.50 (nominal)
Volume Resistivity (Min) in ohm-cm	1 x 10^{14} at 20 deg. C & 1x10^{11} at 70 deg. C.			2.8x 10^{14} at 20 deg. C & 2x10^{11} at 205 deg. C.
C. PAIRING & TWISTING				
Max. lay of pairs (mm)	50			
Single layer of binder tape on each pair provided	Each core printed with number or Numbered binder tape to be provided on each pair		Yes	Each core printed with number or Numbered binder tape to be provided on each pair
Bunch (Unit Formation) for more than 4P	N.A		To be provided	N.A
Conductor /pair identification as per VDE0815	N.A.		To be provided	N.A.
D. SHIELDING				
Type of shielding	Al-Mylar tape			
Individual pair shielding	No		To be provided for F-type cable	No
Minimum thickness of Individual pair shielding	No		0.028mm (28 micron)	No
Overall cable assembly shielding	To be provided			
Minimum thickness of Overall cable assembly shielding	0.055 mm (55 micron)			
Coverage / Overlapping	100% / 20%			

Specification Requirements	Type-A cable	Type-B cable	Type F & G cable	Type-C cable
Drain wire provided for individual shield	N.A.		Yes (for F-type) Size- 0.5 sqmm No of strands-7 Dia of strands- 0.3mm Annealed Tin coated copper	N.A.
Drain wire provided for overall shield	Yes, Size- 0.5 sqmm,No of strands-7,Dia of strands-0.3mm,Annealed Tin coated copper			
E. FILLERS (if applicable)				
Non-hygroscopic, flame retardant	To be provided			
F. OUTER SHEATH				
Material	Extruded PVC compound YM1 with FRLS properties			Teflon (i.e. extruded FRP)
Minimum Thickness at any point	1.8 mm			0.4 mm
Nominal Thickness at any point	>1.8 mm			0.5 mm
Resistant to water, fungus, termite & rodent attack	Required			
Minimum Oxygen index as per ASTMD-2863	29 %			N.A.
Minimum Temperature index as per ASTMD-2863	250 deg.C			N.A.
Maximum Acid gas generation by weight as per IEC-60754-1	20%			N.A.
Maximum Smoke Density Rating as per ASTMD-2843	60% (defined as the average area under the curve when the results of smoke density test plotted on a curve indicating light absorption			N.A.

Specification Requirements	Type-A cable	Type-B cable	Type F & G cable	Type-C cable
	vs. time as per ASTMD-2843)			
Reference standard	VDE207 Part 5,VDE-816			VDE207 Part 6 ASTM D2116
G. Electrical Parameters				
Mutual Capacitance Between Conductors At 0.8 Khz (Max.)	200 nF/km		120 nF/km for F type 100 nF/km for G-type	200 nF/km
Insulation Resistance (Min.)	100 M Ohm/Km			
Cross Talk Figure (Min.) At 0.8 Khz	60 dB		60 dB	60dB
Characteristic Impedance (Max) At 1 Khz	N.A.		320 OHM FOR F-TYPE 340 OHM FOR G-TYPE	N.A.
Attenuation Figure At 1 Khz (Max)	N.A.		1.2 db/km	N.A.
H. COMPLETE CABLE				
Complete Cable assembly	Shall pass Swedish Chimney test as per SEN-SS 4241475 class F3.			N.A.
Flammability	Shall pass flammability as per IEEE-383 read in conjunction to this specification			As per manufacturer's standard subject to employer's approval
I. CABLE DRUM				
Type	Non-returnable wooden drum (wooden drum to be constructed from seasoned wood free from defects with wood preservative applied to entire drum) or steel drum.			

Specification Requirements	Type-A cable	Type-B cable	Type F & G cable	Type-C cable
Length	1000 m ± 5% for up to & including 12 pairs 500 m ± 5% for above12 pairs			

Note: Heat resistant instrumentation cable shall have same specification as of G/F type instrumentation cable as specified above, except that insulation and outer sheath material shall be Teflon and cable shall be suitable for continuous operation at 205 Deg. C

3.00.00 SPECIFICATION OF OPTICAL FIBER CABLES (OFC)

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

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

3.03.00 All testing of the fiber optic cable being supplied shall be as per the relevant IEC, EIA and other international standards.

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

3.05.00 Spliced / Repaired cables are not acceptable.

3.07.00 Penetration of water resistance and impact resistance shall be as per IEC standard.

4.00.00 SPCIFICATION OF CONTROL & POWER SUPPLY CABLES

Refer Electrical sub-sections.

5.00.00 **General guidelines for all cables**: -----

1 Normally 10% spare cores shall be provided when the numbers of pairs of cables are more than four pairs, except for pre-fabricated cables which shall be as per manufacturer's standard.

2 For analog signals, individual pair shielding & overall shielding & for Binary signals, only overall shielding of instrumentation cables shall be provided.

~~6.~~00.00 **TERMINAL BLOCKS**

6.01.00 All terminal blocks shall be rail mounted/post mounted, cage clamp type with high quality non-flammable insulating material of melamine suitable for working temperature of 105 deg. C. The terminal blocks in field mounted junction boxes, temperature transmitters, instrument enclosures/racks, etc., shall be suitable for cage clamp connections. The terminal blocks in Control Equipment Room logic/termination/marshalling cubicles shall be suitable for post mounted cage clamp connection at the field input end. 20% spare terminals shall be provided in Junction boxes panels, etc. The exact type of terminal blocks to be provided by the Bidder and the technical details of the same including width etc. shall be subject to Employer's approval.

6.02.00 All the terminal blocks shall be provided complete with all required accessories including assembly rail, locking pin and section, end brackets, partitions, small partitions, transparent covers, support brackets, distance sleeves, warning label, marking, etc.

7.00.00 **INTERNAL PANELS/ SYSTEM CABINETS WIRING**

7.01.00 Internal panel/cabinet wiring shall be of multi-stranded copper conductor with FRLS PVC insulation without shield and outer sheath meeting the requirements of VDE 0815.

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

7.06.00 Wire sizes to be utilised for internal wiring.

(i)	Current (4-20 mA), low voltage signals (48V); Ammeter/Voltmeter circuit, control switches etc. for electrical system.	0.5 Sq.mm.
(ii)	Power supply and internal illumination.	2.5Sq.mm. minimum (shall be as per load requirement.)

8.00.00 **INSTRUMENTATION CABLE INSTALLATION AND ROUTING & LAYING**

8.01.00 All cables assigned to a particular duct/conduit shall be grouped and pulled in simultaneously using cable grips and suitable lubricants. Cables removed from one duct/conduit shall not be reused without approval of Employer.

8.02.00 Cables shall be segregated as per IEEE Std.-422. In vertically stacked trays, the higher voltage cable shall be in higher position and instrumentation cable shall be in bottom tier of the tray stack. The distance between instrumentation cables and those of other system shall be as follows:

From 11 kV/6.6 kV/3.3 kV tray system	-	914 mm
From 415V tray system	-	610 mm
From control cable tray system	-	305 mm

8.03.00 Cables shall terminate in the enclosure through cable glands. All cable glands shall be properly gasketed. Sealing (to prevent ingress of dust entry and propagation of fire) shall be

provided for all floor slots used for cable entrance. Compression cable glands (double for armoured and single for other cables) shall be provided.

8.05.00 The cables emanating from redundant equipment/devices shall be routed through different paths. The above segregation of cables & wiring for redundant equipments/devices shall be in accordance with IEEE-Std-422.

8.06.00 all cable shall be laid properly with marking at every 10 m on tray neatly dressed Suitably tied up with the tray. 300 mm separation between power & control & instrumentation cables to be ensured while laying. OFC cable shall be inside conduits outside the main building. UTp cables inside the conduits shall be laid.

10.00.00 FIELD MOUNTED LOCAL JUNCTION BOXES

(i)	No. of ways	12/24/36/48/64/72/96/128 with 20% spares terminals.
(ii)	Material and Thickness	4mm thick Fiberglass Reinforced Polyester (FRP).
(iii)	Type, Mounting & accessories	Screwed at all four corners for door. Door gasket shall be of synthetic rubber. Suitable for mounting on walls, columns, structures etc. The brackets, bolts, nuts, screws, glands required for erection shall be of SS, included in Bidders scope of supply
(v)	Type of terminal blocks	Rail mounted cage-clamp type suitable for conductor size upto 2.5 mm^2. A M6 earthing stud shall be provided.
(vi)	Protection Class	IP: 55 minimum for indoor & IP-65 minimum for outdoor applications.
(vii)	Grounding	To be provided.
(viii)	Color	RAL 7035

11.00.00 CONDUITS

11.01.00 Conduits shall be generally used for interconnecting cables from field instruments to Local JB's. All rigid conduits, couplings and elbows shall be hot dipped galvanized rigid mild steel in accordance with IS: 9537 Part-I (1980) and Part-II (1981). The conduit interior and exterior surfaces shall have continuous zinc coating with an overcoat of transparent enamel lacker or zinc chromate. Flexible conduit shall be heat resistant lead coated galvanized steel with, water leak, fire and rust proof protected

for the areas of Mills, Drum, Main Steam, RH steam Air Heaters and Furnace, BFPDT's *And for remaining applications, water leak, fire and rust proof flexible GI conduits shall be provided.* The temperature rating of flexible conduit shall be suitable for actual application.

11.02.00 All rigid conduit fittings shall conform to the requirements of IS: 2667, 1976. Galvanized steel fitting shall be used with steel conduit. All flexible conduit fittings shall be liquid tight, galvanized steel. The end fittings shall be compatible with the flexible conduit supplied.

12.00.00 CABLE SUB-TRAY & SUPPORT

12.01.00 The cable sub-trays and the supporting system, to be generally used between Local/Group JBs and the main cable trays and the same shall be furnished and installed by the

Contractor. It is the assembly of sections and associated fittings forming a rigid structural system used to support the cable from the equipment or instrument enclosure upto the main cable trays (trunk route).covers on cable sub-trays shall be provided for damaging areas.

SUB–SECTION – IIIC-08

CONTROL VALVES AND ACTUATORS

CONTROL VALVES, ACTUATORS & ACCESSORIES

1.00.00	**CONTROL VALVES, ACTUATORS & ACCESSORIES**
1.01.00	**General Requirements**
1.01.01	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, and other standards specified elsewhere 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.
1.01.02	All the control valves and accessories offered by the Bidder shall be from reputed, experienced manufacturers of specified type and range of valves.
1.01.03	For special type of control valves such as combined pressure and temperature control valves for Aux PRDS application, separator drain control valves, refer to the corresponding mechanical sections.
1.01.04	Specification for control valves in this Sub-section has to be read in conjunction with other relevant Sub-sections of this specification.
1.02.00	**CONTROL VALVE SIZING & CONSTRUCTION**
1.02.01	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.
1.02.02	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 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, which will be subject to Employer's approval during detailed engineering.
1.02.03	Control valves for steam and water applications shall be designed to prevent cavitation, wire drawing, flashing on the downstream side of valve and down stream piping. Thus for cavitation/flashing service, only valve with anti cavitation trim shall be provided. Detailed calculations to establish whether cavitation will occur or not for any given application shall be furnished.
1.02.04	Control valves for application (as applicable), such as Spray Control, Gas control , Emergency Make-up to condenser hotwell, Turbine Bypass control valve ,Deaerator Drain to Condenser Hotwell, Condensate spill to condensate reserve tank, condenser normal make-up and valve gland sealing supplying pressure control, CEPS minimum flow control, **BFP circulation control valve** shall have permissible leakage rate as per leakage Class V. All other control valves shall have leakage rate as per leakage Class-IV **as per ANSI / FCI /70.2,2006 or equivalent**.

1.02.05 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 except for few cases as per contractor's standard and proven practice subject to employer's approval.

1.02.06 Control valves for steam and water application shall be provided with rangability of 30:1 for all services except for applications wherein control valves are envisaged to be operated in lower range like superheater spray system wherein control valve with rangability of 50:1 shall be provided

2.00.00 VALVE CONSTRUCTION

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

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

2.03.00 Cast Iron valves are not acceptable.

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

2.05.00 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.

2.06.00 All valves connected to vacuum on down stream side shall be provided with packing suitable for vacuum applications (e.g. double vee type chevron packing)

2.07.00 Valve characteristic shall match with the process characteristics.

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

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

3.00.00 VALVE MATERIALS

Sr. No.	Service	Body material	Trim Material
1	Non-corrosive, non-flashing and non-cavitation service except DM water	Carbon steel ASTM-A216 Gr. WCB for design fluid temperature below 275 Deg. C Alloy steel ASTM-A217Gr. WC6 for design fluid temperature above 275 Deg. C and upto 400 Deg. C Alloy steel ASTM-A217Gr. WC9 for design fluid temperature above 400 Deg. C	316SS stellited with stellited faced guide posts and bushings.
2.	Severe flashing/cavitation services	Alloy steel ASTM-A217 Gr. WC9	440 C

3.	Low flashing/cavitation service	Alloy steel ASTM-A217 Gr. WC6	17-4 PH SS
4.	DM water service	316 SS	316 SS

NOTE: (a) Valve body rating shall meet the process pressure and temperature requirement as per ANSI B16.34.

(b) Severe flashing / cavitation services includes as a minimum all control valves whose downstream piping is connected to condenser or flash tank.

However, Bidder may offer valves with body and trim materials better than specified materials and in such cases Bidder shall furnish the comparison of properties including cavitation resistance, hardness, tensile strength, strain energy, corrosion resistance and erosion resistance etc. of the offered material vis-a-vis the specified material for Employer's consideration and approval.

Contractor shall ensure that all required measures like proper selection of anti-corrosive/erosive material along with durable epoxy coating with polyurethane finish shall be provided for all the C&I equipment/ devices being supplied in this contract, which are mounted in non-AC areas (prone to sea water environment corrosion / erosion) like measuring instruments, control valves & actuators, JBs, LIEs / LIRs, impulse pipes, sample pipes, fittings, conduits, cable trays and accessories, local control panels, erection hardware items etc. Contractor shall furnish their comprehensive proposal regarding the anti-corrosion/ erosion measures for protection against sea water environment which shall be finalized during detailed engineering subject to Employer's approval.

4.00.00 END PREPARATION

Valve body ends shall be either butt welded/socket welded, flanged (Rubber lined for condensate service) or screwed as finalized during detailed engineering and as per Employer's approval. The welded ends wherever required shall be butt welded type as per ANSI B 16.25 for control valves of sizes 65 mm and above. For valves size 50 mm and below welded ends shall be socket welded as per ANSI B 16.11. Flanged ends wherever required shall be of ANSI pressure-temperature class equal to or greater than that of the control valve body.

5.00.00 VALVE ACTUATORS

All control valves shall be furnished with pneumatic actuators except for pressure and temperature control valve for auxiliary PRDS application (electro-hydraulic / pneumatically operated) and separator drain control valve (electro-hydraulic type).The Bidder shall be responsible for proper selection and sizing of valve actuators in accordance with the pressure drop and 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 for stem force, 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 unless otherwise specified.

The travel time of the pneumatic actuators shall not exceed 10 seconds.

6.00.00 **CONTROL VALVE ACCESSORY DEVICES**

6.01.00 All pneumatic actuated control valve accessories such as air locks, hand wheels/hand-jacks, limit switches, microprocessor based electronic Positioner, diffusers, external volume chambers, position transmitters (capacitance or resistance type only), reversible pilot for Positioner, tubing and air sets, solenoid valves and junction boxes etc. shall be provided as per the requirements.

7.00.00 **SPECIFICATIONS FOR MICROPROCESSOR BASED ELECTRONIC POSITIONER**

1	Electrical	a) Input Demand Signal	4-20 mA
		b) Power Supply	Loop Powered from the output card of Control System.
		c) HART Protocol	Compatibility for Remote Calibration & Diagnostics (Super-imposed HART signal on input Signal (4-20 mA)
		d. Valve position sensing	Position sensing, 4-20 mA output signal to be provided for control system.
2	Environment	a) Operating temp.	(-)30 To 80 Deg. C
		b) Humidity	0-95 %
		c) Protection class	IP-65 Minimum
3	Software for Configuration and Diagnostics	Software	Software shall meet the requirements for Configuration, Diagnostics, Calibration and Testing of the actuator.
		Diagnostic/Test features	Advanced diagnostic features like Stroke counter or Travel counter, Leakage in actuators, Valve Signature analysis, Step Response test, Valve friction /Jamming detection etc to be provided.
4	Test reports/ Certificates	Factory Valve Signature Tests Reports (Pr Vs Valve travel and Travel Vs I/P signal) are to be provided.	
		Test certificates as per Manufacture Standard/Relevant Standard are to be submitted.	
5	Configuration/ Calibration.	Remote & Local Calibration, Auto & Manual Calibration shall be possible.	
6	Operating Range	Full range/ Split range.	
7	Modes	Valve Action	Direct / Reverse Valve Action

		Flow Characterization	Possible to fit Valve Characteristic Curves- Linear , Equal percentage etc.
8	Fail Safe/Fail Freeze	Fail Safe/Fail Freeze feature is to be provided. (In case the fail freeze feature is not intrinsic to the positioner, Bidder shall achieve the same externally through solenoid valve connected in the pneumatic circuit).	
9	Pneumatic	Air capacity	Sufficient to handle the valves & actuators selected/ Boosters to be supplied, if required.
		Air pressure	To suit the air supply pressure/quality available.
		Process connection	¼" NPT
10	Performance	Characteristic deviation	<=0.5 % of span.
		Ambient temp effect	<=0.01 %/ deg C or better.
10	EMC & CE Compliance	Required to International Standard like EN/IEC.	EN50081-2 & EN50082 or equivalent.
11	Accessories	In-built Operator Panel	Display with push buttons for configuration and display on the positioner itself (Password protected/Hardware lock).
		Hand Held Hart Calibrator	Universal Hart Calibrator to be provided (for quantity, refer Part-A: Contract quantities of the specification).
		Press Gauge Block	For supply & output pressures, Air Filter Regulator and other accessories shall be provided on as required basis for making system complete.
		Electrical Cable Entry	1/2'"NPT, side or bottom entry to avoid water

			ingress.
		Valves Mounting Assembly	For Sliding Stem/Rotary/Single acting/Double acting actuators on as required basis

8.00.00 TEST AND EXAMINATION

All valves shall be tested in accordance with the quality assurance programme agreed between the Employer and Contractor, which shall meet the requirements of IBR and other applicable codes mentioned elsewhere in the specifications. The tests shall include but not be limited to the following:

8.01.00 Non Destructive Test as per ANSI B-16.34.

8.02.00 Hydrostatic shell test in accordance with ANSI B 16.34 prior to seat leakage test.

8.03.00 Valve closure test and seat leakage test in accordance with ANSI-B 16.34/ FCI 70.2 standard and as per the leakage class indicated above

8.04.00 Functional Test: The fully assembled valves including actuators control devices and accessories shall be functionally tested to demonstrate times from open to close position.

8.05.00 CV Test: Please refer Cl No. 1.00.00 & 3.00.00 OF Sub-section- IIIC-10 (Type test requirements), Control Valves.

Bidder shall furnish all the control valves under this main plant package as finalized during detailed engineering stage without any price repercussions whatsoever depending on the process requirements. All the control valves provided by the Bidder for this project shall meet the specifications requirements specified herein. Specification for control valves in this Sub-section has to be read in conjunction with other relevant Sub-sections of this specification.

SUB–SECTION – IIIC-09

Control desk, panels, furniture
&
CCR design Guidelines

1.00.00	**CONTROL DESK & PANELS**
1.01.00	**GENERAL**
1.01.01	All control desk, panels, LVS panel etc. shall be furnished fully wired with necessary provision for convenience outlets, internal lighting, grounding, ventilation, space heating, anti-vibration pads, internal piping & accessories as required for completeness of the system.
1.01.02	All panels, desks, cabinets shall be free standing type & have bottom / top entry for cables to be finalised application wise during detailed engineering stage. The bottom of desk & cabinets shall be sealed with bottom plate, compression cable glands (double for field and single for inside rooms) and fire proof sealing material to prevent ingress of dust and propagation of fire. Sufficient number of power receptacles with disconnect switches shall be installed within all panels/desk.
1.01.03	Exterior steel surface shall be sand blasted, ground smooth, filled, primed, sanded and smooth enamel painted to give a good finish subject to minimum paint thickness of 65-75 microns for sheet thickness of 3 mm and 50 microns for sheet thickness of 2mm. The exact color shall be finalised during detailed engineering.
1.01.04	The design shall conform to the EN ISO 11064 (Ergonomical design of control room), Part-1,2 and 3.
2.00.00	**CONTROL DESK & PANEL**
2.01.00	**GENERAL**
2.01.01	The exact dimensions, material, construction details, grounding, general arrangement etc. of Control Desk etc. shall be as per the actual requirement and shall be finalised during detailed engineering and subjected to Employer's Approval. For bidding purpose, the length of the desk/ panel and CD mounted devicesas decided during detailed engineering.
2.01.02	For control desk mounted instruments/ devices etc., which are to be powered from UPS, all required conversion of interface equipments / accessories to make such devices compatible with UPS supply shall be provided. All necessary hardware like Input switches/ fuse unit for each feeder as well as switch fuse unit for each instrument/ device on the power supply line shall be provided. From UPS, redundant feeders shall be provided with suitably rated MCB and provision of fast auto changeover of UPS feeders.
2.02.00	**Control Desk (CD)** Control desk **shall be Modular, non-welded construction** free standing table top type with **front &** back **cover** constructed of **1.6** mm thick CRCA steel plates**.** The tabletop of the control desk shall be arc-shaped for mounting **TFT** monitors **and synchroscope** . **TFT monitors and synchroscope shall be provided with adjustable mounting arrangement.** The work surface of control desk shall be 30mm thick with the top 12mm of Acrylic Solid Surface **(ASS)** and the remaining 18mm of laminated medium density fiber board**. Work surface shall be made of two different colors at same level and seamlessly joined in each section**. **The structure frame shall consist of extruded aluminum top and bottom horizontal beams and vertical support tensioned together to form an integrated, finished curvilinear shaped frame. Vertical & Horizontal supports, minimum 2.5mm and 2mm thick respectively, have to be provided for the structure frame. Extreme side legs shall be illuminated type and should complete the overall form and aesthetics of the desk. It shall have**

concealed cable & wire way management system. PA system hand sets, telephone sets, very few PB stations and lamps shall be mounted on the control desk on mosaic grid structure as per attached list. Sliding keyboard trays shall be provided on the CD. The exact profile of the desk, dimension and the radius of curvature shall be finalised during detailed engineering stage.

2.02.01 All operator monitors & mice shall be mounted on this CD.

2.02.02 The cabling / wiring between OWS & CPU's, power supply cables etc. shall be aesthetically routed and concealed from view.

2.03.00 **Hardwired devices on Control Desk (CD) (draw out section)**

2.03.01 CD shall be provided with a draw out section where hardwired devices shall be mounted on a mosaic grid mosaic portion for mounting backup.. The mosaic grid tiles shall be of 24 mm x 48 mm (or 25 mm x 50 mm) size, made of heat and flame retardant, self extinguishing and non-hygroscopic material with flat matt finish without glare and non reflecting type.

2.04.00 **Control Desk Devices**

"Release" & Lamp Test push buttons shall be provided for a set of push buttons/Auto/Manual stations. Depending on the type of control/function and required number of push buttons and indicating LEDs & their color, push button stations shall be selected.

Emergency push buttons(with cover) shall be mounted on top of CD, as per quantity indicated in Part-A of specification.

2.04.01 Internal Panel/Desk Items

2.05.00 Equipment and devices mounted within the panels/desk shall be mounted on suitable racks/brackets and shall be arranged for convenient access for adjustment and maintenance work.

2.06.00 **Furniture**

2.07.00 **Bidder sh**all provide following industrial grade furniture items as a minimum from reputed manufacturers/suppliers meeting International Standards. The furniture shall be modular and latest with ease of operational features. The furniture shall be modern, aesthetically designed, modular, flexible, space saving and future safe. Each module shall have transparent cover and adjustable partition. It shall have locking provision for security. The components shall be suitable for integration/fabrication without any welding technology.

1. Work Station furniture

   Modular work station furniture, suitable for mounting servers & historians, programmer stations, PC based systems, printers (inkjet or A4 laser) etc. is to be provided..

2. Server Rack

Server rack shall be provided to mount programmer stations, PC based systems (of rack type and tower type), , Mini UPS etc. in Programmer room. Suitable arrangement for Ventillation and cooling shall be built in.

3. PC rack

PC rack shall be provided to mount CPUs of work stations/PCs of OWS/LVS etc in Control Room.

4. Chairs

20 NOS Industry standard revolving chairs with wheels and with provision for adjustment of height (hydraulically/gas lift) shall be provided for the operators, other personnel in control room area. These shall be designed for sitting for long duration such that these are comfortable for the back.

5. Tables

a Industry standard computer tables shall be provided & shall be as approved by Employer during detailed Engineering.

b Conference Room standard tables shall be provided with acrylic coat for good finish. Details shall be finalised & approved by Employer during detailed engg.

6. Keypad

Keypads shall be provided for the storing of keys of relevant areas in the respective control rooms

7. Lockers

Suitable lockers shall be provided in the room adjacent to the control room for storing of personal articles of control room personnel & also for documents.

3.00.00 LVS PANEL

3.01.00 An arc shaped Large Video Screen (LVS) panel shall be supplied for mounting large video screens in number of tiers in various Control rooms as specified at Part-A of specification.

3.02.00 The profile, dimensions and the general arrangement shall be finalised & approved by Employer during detailed engineering. Recommendations, if any, for the control room lighting in order to ensure continuous proper viewing of the LVS screen by the operator & shift incharge (without any fatigue) shall be clearly brought out by the Contractor in his offer, along with all relevant details/basis.

3.03.00 Any other requirement for proper LVS mounting & functioning & viewing shall also be specifically brought out by the Contractor in his offer, along with all relevant details.

4.00.00 **CENTRAL CONTROL ROOM (CCR) DESIGN GUIDELINES**:-

4.00.01 The Contractor shall provide an integrated design for a modern state-of-the-art control room and its adjacent areas. For this, contractor to appoint a qualified Architect company having experience in control room design of thermal power plants. The Contractor shall develop computerized models for the control room covering layout, color scheme, selection of material, requirement of various material, etc.

4.00.02 The equipment which will be present in the control room or in the adjacent areas are as follows:-

a. Control room – operator desk along with monitors, Single tier of Large Video Screens (LVS) mounted on LVS panel, PC racks behind LVS panels, a few PCs and printers etc. with associated furniture.
b. Programmer's room – Required quantities of PCs and workstations and network devices with associated furniture.

4.01.00 **Technical Details**

The Control Room design shall take into consideration the control/operation/monitoring devices being employed and the relevant international standards like DIN/VDE/VDI/IEC/EN. As a minimum the following aspects shall be considered at the time of design :

- Proper Illumination, Acoustics (<30dB continuous), color coordination, ergonomic aspects, environmental conditions, conducive ambiance, firefighting, health & safety of personnel, cable management & support facilities shall be provided.

Contractor shall ensure full coordination of the colour of various components of the control room viz. walls, false ceiling, floor, control desk & other furniture which shall be aesthetically appealing.

The lighting shall take into account the requirements of Large Video Screen (LVS) operation and shall ensure that there is no reflection from the LVSs. Automatic adjustment of intensity based on ambient conditions shall be provided, suitable for normal human eye.
Emergency lighting shall also be provided.

The desk along with LVS shall be designed keeping in view aesthetics, ergonomic considerations, anthropometrics, and anthropotechniques to ensure ease of operation with maximum comfort. Specially designed furniture shall be provided.

4.02.00 **Other Equipment**
Control Room shall be equipped with necessary support facilities and equipment such as conference rooms, document rooms, pantry, dining room, tea/coffee/water dispenser, toilets, lockers, automatic opening doors etc for smooth and comfortable working of the operating personnel.

SUB–SECTION – IIIC-10

Public address system

PUBLIC ADDRESS SYSTEM

1.00.00 PUBLIC ADDRESS SYSTEM (PAS)

General Requirements

1.01.01 The intent of the specification is to define the functional & design requirements for the Public address system. The Contractor shall be responsible for selection, design, engineering, manufacturing, testing at manufacturer's works/ site, erection, installation and commissioning of public Address system meeting the intent and functional requirement of specifications.

1.01.02 The Bidder's scope shall also include successful demonstration of performance testing specified herein complete in all respects. All the items, including public Address system erection hardware, racks, cables, cable trays, conduits, etc. as required, for the proper installation (conforming to IS:1881, IS:1882) to make the IP based PA system complete and functional are under Contractor's scope on as required basis. All equipment, accessories and facilities required for completeness of this system shall be furnished by the Contractor within the quoted lump sum price, whether these are specifically mentioned herein or not.

1.01.03 The equipment furnished under this section shall meet the requirements of all-applicable codes and standards as specified in Part-C, Section-VI or their equivalent international codes and standards.

1.01.04 The Public Address System (PAS) offered by the Bidder shall be from reputed manufacturer who should have designed, manufactured, tested and commissioned a distributed amplifier type industrial Public Address systems as specified in thermal power plants or large industrial installation as on the date of bid opening.

1.01.05 The system shall be adequately protected from signal and power line noise and meet the Surge Withstand Capability (SWC) requirements of ANSI C37.90 A/IEEE standard 472-1989 or equivalent. Equipment shall be self-protecting against transients in the input ac supply

1.01.06 The Bidder shall guarantee satisfactory performance of the equipment under stipulated variations of voltage and frequency. The design and manufacture shall be such that equipment/components of same type and rating shall be interchangeable.

2.00.00 POWER SUPPLY ARRANGEMENT

2.01.00 The PA system along with all its system components i.e. network switches, servers, media converters, PC stations etc. shall be powered from UPS system as detailed in Sub-section-Power Supply, Part-B, and Section – VI. Contractor shall also provide local power distribution boxes (as detailed in Sub-section-Power Supply, Part-B, and Section – VI) as required for sub-distribution of UPS supply.

2.02.00 For call stations & amplifiers, mini UPS of suitable rating are to be provided by the Contractor within his quoted lump sum price. Contractor shall also provide local power distribution boxes as required for sub-distribution of supply from mini-UPS to call stations & amplifiers. The location of mini-UPS & power distribution scheme shall be finalized during detail engineering.

2.03.00 If the offered equipment is operating at voltage level other than what has been specified in Sub-Section: Power Supply, Part-B, Section-VI, the Contractor shall provide all required hardware, within lump sum quoted price to make the offered system compatible with specified power supply arrangement

3.00.00 **System Description**

3.01.00 **DESIGN AND TECHNICAL REQUIREMENTS**

3.01.01 The PA system shall be designed as standalone IP based network architecture. The system shall be based on centralized control together with distributed nodes permitting speech broadcasts and pre-recorded messages /alarm tones etc. The PA system shall be designed such that no single failure shall disrupt the availability of complete system. Redundant servers will cater to complete plant. These servers shall be located at Unit CCR.

3.01.02 the carrier system shall be based on Voice Over IP, extended to provide IP communication across the complete PA system. The call stations and standalone amplifiers shall be individually IP addressable. Any conversion of the analog field call station to IP mode by separate attachment of the intelligent module/ unit shall not be acceptable. Each call station should be able to selectively call another call station without manual intervention of any other equipment. The design shall be such as to provide highly intelligible full duplex voice communication even in areas of high background noise (up to 80 db).

3.01.03 PA System Management Software:

Configuration of the system shall be achieved by user Friendly GUI based software for maximum flexibility, easy re-configuration, maintenance & future expansion. This software should be configured on a PC station, located at Unit CCR which enables an operator to implement speed commissioning and also carry out routine diagnostic checks / fault finding functions of PA system components. It should be possible to make adjustments when the system is installed without resulting in modification to the system wiring. It shall be possible to download/ store the configuration parameters & scheme from the server without taking the system out of service. Levels of system access and privileges shall be maintained through security passwords etc. The software shall be able to work with the latest windows version. All software utilized shall be latest and upgraded version.

3.01.04 Built in Diagnostic features:

The Bidder shall provide all hardware/software in order to have a comprehensive built in diagnostic test feature covering the complete PA system components including call stations & amplifiers, standalone amplifiers along with associated loudspeakers, servers, network components i.e. network switches and interconnecting cables, power supplies etc. so that at all times, the status of the complete system can be monitored. Active fault reporting concerning all aspects of PA system shall be extended to PC Stations which shall record the system malfunction messages with time & date stamp.

3.01.05 Recording functionality for calls to and from master call station in each zone shall be provided. System shall ensure that once recorded, audio cannot be altered.

3.01.06 The system shall be able to accept potential free contacts from other systems (like fire alarm system, security system and access control system etc.) for predefined actions (like fire or security alarm announcement on call stations (configurable) etc.) For implementation of the same, 10 nos. potential free contacts per unit, 10 nos. potential free contacts for CHP and 10

nos. potential free contacts for common plant area shall be provided by Employer for interfacing with PA system. The exact details shall be finalized during detail engineering.

3.01.07 **CALL STATION,amplifier, LOudspeaker & server**

Call Stations shall be of the following types:

(a) Outdoor Wall/column mounting type.(Type - A)

(b) Indoor desk-top mounting type. (Type - B)

Each Call Station shall have LCD indicator, 10 digit dial pad & 2 special keys, Pre-amplifier & power amplifier, Indication for 'Power Supply On' and 'Network Connection Healthy' as a minimum.

The outdoor wall/column mounting type call station shall be dust-tight and weather proof, with appropriate protection against direct rain, ingress of dust and moisture conforming to IP-65 degree of protection as per IS/IEC:60947-1, outdoor wall/column mounting type. The indoor desk-top mounting type call station shall have a degree of protection of at least IP-32. All call stations and their components shall be capable of continued satisfactory operation at an ambient temperature at 55 Deg C.

The indoor desk mounting type call stations shall preferably be PoE powered and the same shall be IEEE 802.a.f compliant.

3.01.08 **AMPLIFIERS**

Amplifiers shall be solid state, class-D, push-pull type, in built with the call station fully conforming to IS: 10426 or equivalent international standard.

Amplifier shall have 0-100% volume control facility for coarse and fine setting, Input sensitivity control, Receiver volume control, Bass cut filter and Anti-side tone control feature

3.01.09 **LOUDSPEAKERS**

Indoor loudspeaker shall be cone type housed in sturdy metal cabinet suitable for wall/column mounting. The mounting bracket shall be treated with acoustic under-coats to prevent resonance. They shall have IP-52 degree of protection as per IS/ IEC:60947-1.

Outdoor loudspeaker shall be industrial horn type and of pressure die cast aluminum or equivalent industrial grade material construction. The mounting bracket shall be with adjustable base suitable for vertical and horizontal orientation. They shall have IP-65 degree of protection as per IS/ IEC:60947-1.

3.02.00 **SERVER**

The server shall be based on state of art VOIP technology. The server should support protocols including SIP or equivalent, TCP, IPV4/ IPV6, Codec G.722, SNMP, RTP, NTP etc. Suitable built in IP security such as firewall, SSH, HTTPS etc. shall be provided in server. The server should be able to support the required number of call stations with future provision as defined in Part-A of the specifications. The required no. of all hardware/software licenses to meet the Employer specifications shall be supplied by the Contractor.

The server shall be capable of self-recovery in case of any fault/ network break down. It shall be rack mounted type.

the server shall be able to support minimum 4 channels for GSM communication with PA system. Suitable interface for the same shall be provided by Contractor.
All programming tools & software that are required to program/ reprogram the system shall also be provided along with the server.

PC station alongwith network switches shall be provided for overall viewing and monitoring of PA system functionality

3.04.00 CABLES AND JUNCTION BOXES

(i.) The bidder shall supply the all required cables for PA system on as required basis. Colour of the outer sheath shall be YELLOW. All cables of PA system shall be armoured, if unarmoured, the same shall necessarily be laid in GI conduits.

(ii.) Cables shall be of FRLS PVC sheathed cables for use in PA system and shall conform to latest edition of Indian/International standards.

(iii.) Fiber optic cables are to be provided as required .For specifications of Fiber Optic cables & interconnecting cables and their laying, refer subsection INST CABLE.

Twisted multipair, multistring with at least one spare pair, minimum 0.5 mm2 cross section, annealed copper (shielded and armoured) shall be provided for Loud speakers.

4.00.00 **TECHNICAL PARTICULARS**

Public Address Systems shall conform to the following technical parameters.

Items	Technical Particulars
(i) Amplifiers	
(a) Band width (± 3 db)	100-16000 Hz
(b) THD	< 0.5% at 1 KHz at rated output
(c) Signal to Noise Ratio	Min. 80dB
(ii) Microphones	
(a) Band width (±3 db)	Codec G.722, 200-7000Hz

(b)	Type	Omnidirectional & Dynamic noise cancelling type
(iii)	Loudspeakers	
(a)	Outdoor	wall/column mounted Horn Type
(i)	Capacity	105 dB for broadcast, 95dB for call mode, 15 W (RMS)
(b)	Indoor	wall/column mounted Cone Type
(i)	Capacity	85dB , 4W (RMS)

SUB–SECTION – IIIC-11

CCTV

1.00.00 CLOSED CIRCUIT TELEVISION (CCTV) SYSTEM

1.01.00 General Requirements

1.01.01 The intent of the specification is to define the functional & design requirements for the CCTV System meant for gathering video information from the various areas of the power plant. The Contractor shall be responsible for selection, design, engineering, manufacture, testing at manufacturer's works/site, installation of all the equipments supplied as covered in this specification and commissioning of the system meeting the intent & functional requirements of the specification. All the cables, cable trays, power packs, erection hardware (viz. junction boxes, brackets glands, nut-bolts, conduits etc.) are also included in Contractor's scope.

1.01.02 The Contractor's scope shall also include successful demonstration of functional requirements & shall guarantee performance under frequency & voltage variation specified herein complete in all respects.

1.01.03 The design and manufacture shall be such that equipment / components of same type and rating are interchangeable.

1.01.04 The number of camera units, servers, network switches, wireless equipment etc. and their locations are listed at Appendix-1 to Part A of technical specifications.

1.01.05 Any other equipment, module, software required for the safe and satisfactory operation, control, protection, monitoring, testing and maintenance of the system shall also be included by the Bidder within the lump sum quoted price.

1.01.06 The equipment furnished under this section shall meet the requirements of all the applicable International codes and standards as specified in Part-C, Section-VI or their amendment Codes and Standards. Camera certification has to be CE/FCC/UL or equivalent.

2.00.00 POWER SUPPLY ARRANGEMENT

2.01.00 The CCTV System along with all its system components i.e. network switches, storage devices, servers, LAN switches, media converters etc. shall be powered from UPS system as detailed in Sub-section-Power Supply, Part-B, Section – VI. Contractor shall also provide local power distribution boxes (as detailed in Sub-section-Power Supply, Part-B, Section – VI) as required for sub-distribution of UPS supply.

2.02.00 For cameras, mini UPS of suitable rating are to be provided by the contractor within his quoted lump sum price. Contractor shall also provide local power distribution boxes as required for sub-distribution of supply from mini-UPS to cameras. The location of mini-UPS & power distribution scheme shall be finalized during detail engineering.

2.03.00 If the offered equipment is operating at voltage level other than what has been specified in Sub-Section: Power Supply, Part-B, Section-VI, the Contractor shall provide all required hardware, within lump sum quoted price to make the offered system compatible with specified power supply arrangement.

3.00.00 DESIGN AND TECHNICAL REQUIREMENTS

3.01.00	The CCTV system shall be able to provide surveillance of different locations in the plant as listed at Appendix-1 to Part A of technical specifications. Contractor to note that the locations indicated therein are indicative and broad only. The exact locations shall be decided during detailed engineering. The Bidder shall refer to General Layout Plan and Equipment Location Plans for the various operational areas of the power plant. The CCTV system shall be designed as a standalone IP based network architecture. System shall use video signals from different cameras at different locations, process the video signals for viewing on monitors at different locations and simultaneously record all the video streams using H.264 or better compression technique. Joystick and mouse-keyboard controllers shall be used for Pan, Tilt, Zoom and other functions of desired cameras.
3.02.00	system shall have the followings:- i) Set of Cameras with Housing, Pan, Tilt and zoom Control as required. ii) Required nos. of Monitors, key board, joysticks etc., iii) Set of camera management/database servers for management of cameras in that zone and for storage and recording all the video signals from each of the cameras within the zone. iv) Set of network switches to control and integrate the above.
3.03.00	The camera and database servers shall offer both video stream management, video stream storage management. These servers shall also manage and store configuration information/database for the whole system. Recording frame rate & resolution in respect of individual camera shall be programmable. It shall be possible to view and record at different resolutions and frame rates and this shall be individually programmable on every camera. The system shall ensure that all configuration information, video recordings, and user database etc., is automatically replicated on the standby camera/database server(s) so that in the event of failure of one server, the performance of the system is not affected. It shall be possible to take back-up of system configuration and database on portable media device and restoring the same if required.
3.04.00	System shall ensure that once recorded, video can not be altered.
3.05.00	Camera server shall be provided with sufficient storage space to store recordings of all cameras at 25 FPS, 4CIF(For SD cameras) & 25/30 FPS at 1920X1080 (For HD cameras)for a period of Fifteen (15) days or more using necessary compression techniques. All recordings shall have camera ID, Location, Date and time of recording.
3.06.00	Facility shall be provided to select a camera or a group of cameras in a zone for recording in CIF, 2CIF or 4 CIF resolution (For SD cameras) & CIF, 2CIF ,4 CIF,HD(720P) & Full HD (1080P) resolution(For HD Cameras).
3.07.00	It shall be possible to export selected portion of recording to portable media devices. The exported clip shall be in commonly used movie file formats e.g. MPEG, AVI and no special software shall be required to view the same.
3.08.00	Server software shall allow the clients seamless operation of all cameras regardless of the actual connection to different recording servers. Software shall allow the client applications to interact with all the camera/database servers simultaneously and allow simultaneous display of live video/recorded video regardless of the zone in which the client is connected.
3.09.00	It shall be possible to view, record, search and replay simultaneously without affecting performance of the system.

3.10.00 The system operation would be of covering the complete view of the areas with pan / tilt, zoom, propositioning of the cameras and with programmability to monitor any camera on any monitor either manually or automatically in a defined switching. The system shall be suitable for installation and shall be able to work successfully in dust prone thermal power plant environment. The system supplied shall be complete in all respects for reliable performance. The Contractor shall submit the detailed block schematic, video, signal & power wiring diagram, describing the connections between the network switch/camera server Systems and various cameras, monitors, keyboard, and joystick.

3.11.00 There shall be an interface to Plant security system through L3 switch of the CCTV system, so that the camera feeds of the CCTV system can be viewed in the Security Operation Centre (SOC) of the plant located near main gate & also cameras of security system can be viewed by operators, if needed. Cables & associated accessories between L3 switch of CCTV system & network switch of SOC will be in vendor's scope.

3.12.00 The camera & Video Management Software shall conform to ONVIF Profile S or latest available applicable ONVIF profile at the time of detail engineering.

4.00.00 **DETAILED DESCRIPTION OF THE SYSTEM COMPONENTS:**

4. .01.0 Application Software for Video Monitoring, Recording & Management.

The application software shall be used to display, store, control & manage the entire surveillance system.

it shall be possible to control all cameras i.e. PTZ , auto/manual focus, selection of presets, video tour selection etc. The software shall support flexible 1/2/4 windows split screen display mode or scroll mode on the display monitors for live video.

It shall be possible to define priority based camera control rights for each camera or a group of cameras. The users shall be defined on a hierarchical basis with a minimum of three levels. A higher priority user can take control of camera being controlled by a lower priority user. In addition the user shall have facility to request access of any camera and if the existing situation permits the user shall be able to control the camera.

The software shall be programmable with at least 50 sequences that can run independently of each other in either forward or reverse direction. The sequences shall support simultaneous switching on multiple image panes or monitors. The sequences shall also support camera prepositions for each camera on each sequence step.

The system administrator shall have rights to add/delete/configure users with rights. It shall be possible to view the rights of each user or the cameras which can be viewed / controlled by each user. It shall also be possible to add/delete cameras, configure cameras, assign priorities to users, configure alarm monitors etc. It shall also be possible to configure user groups with different rights and assign users to user groups. The system shall support unified log-in through out the system and it shall be possible for any user to log-in from any location/client and access cameras/recordings and other features as permissible depending on his or her rights assigned to his or her log-in.

The system shall have different recording modes i.e. continuous, manual, programmed, event activated etc. on date, time camera wise. It shall be possible to configure each mode using user friendly tools. It shall be possible to search and replay the recorded video date, time, camera, event wise.

The system shall include on screen display for time-date, camera number/camera ID, and status information. The system shall have provision for logging through printer output port, which shall provide permanent record of system status showing time and date of changes such as: incoming alarms, acknowledgement of alarms, loading of sequences, user log-on to key board, transfer of system tables and sequence, video loss messages, and a power up reset message, thus hard copy of the system's configuration tables and sequences can be obtained.

The system shall have alarm interface capability. When an alarm occurs in the Camera/Database Server, the live video output of the camera associated with that alarm shall be switched directly to a predefined monitor/monitors. The user shall be able to acknowledge the alarm to clear the monitor using the numeric keypad or mouse. Cameras that are directed to such pre-defined monitors will not be removed from the queue unless explicitly cleared by the operator. It shall be possible to create a queue of such pre-defined monitors to manage multiple alarm views simultaneously. The system shall maintain a single alarm stack for the complete system, which shall include events received from other system, or events detected by video analytics, network loss, video loss etc. It shall be possible to assign priorities to alarms. System shall maintain audit trail for alarms and actions taken by users in response to alarm shall be recorded and made available for audit.

On screen controls shall be provided to achieve remote operation i.e. PTZ operation of cameras.

The software for clients shall preferably work on a browser based system .This will allow any authorized user to display any video (live/recorded) of any camera on the monitor with associated controls. It shall be possible to play back recorded video at different speeds i.e. 1/4X to 16 X. The system shall support multiple live video on single monitor in different configurations like 1, 2, 4 etc.

It shall be possible to retrieve recorded video without much delay for any date/time interval.

The system shall support video analytics in respect of the following

1. Video motion detection

2. Object tracking

3. Object classification & Tracking

The feature can be an integral part of camera or a part of camera server. The features shall be user configurable for each camera. It shall be possible to activate recordings automatically based on events generated by video analytics. These events shall also be logged and suitably alarmed on the monitors.

Software shall be provided by contractor. The unit level system shall be connected to at least one no monitor, one no. key board and requisite number of servers and cameras. The system shall also have the following provisions.User friendly spreadsheet/ equivalent format providing the ability to enter camera titles, operator name, timely events, change system parameters, program camera sequences and lockouts.

It shall provide high performance programming, control and monitoring of all the system functions by using on-screen icons to reflect real time status of the devices being controlled by the system. Software shall also provide the ability to monitor system status events. Systems alarms, switching functions, sequence events, keyboard actions, and video loss information.

The system shall be able to provide complete system diagnostics. All the Station locations, where additional monitors and keyboards are to be provided for controlling all the station cameras shall be connected to this common plant zone switch.

System shall have the spare capacity to add minimum five nos. client workstations with functionalities of viewing live video/recorded video, PTZ controls of cameras, viewing site maps etc.. Software licenses for the same shall be supplied.

The software shall support video loss and network loss alarm feature.

It is a requirement that all user actions on the system Operator Station be recorded in a log file along with the Security System or Control System's actions. User actions include:

Interventions such as manual recording and configuration setting changes

Cameras viewed, Video replayed, Video exported, Cameras pan/tilt/zoomed and preset switching.

This log must also contain a history of the status of the system components. It shall list the status of all cameras, servers and other system components including when they were disabled or failed. This log shall be maintained for a minimum period of ten (10) days.

4.02.0 **Cameras:**

All the cameras shall be color, suitable for day and night surveillance and network compatible. There will be two types of cameras viz. PTZ & Fixed. PTZ cameras shall be high speed integrated dome type.

Camera shall be directly connected to network and use of external encoder for connecting to network is not acceptable (except for the explosion proof cameras.). The cameras shall be rugged, high performance color cameras. These cameras shall provide high resolution and high sensitivity suitable for operation in a power plant, both in natural and artificial lighted areas.

4.02.01 Detailed technical specification is given below.

a) **PTZ Dome Cameras**

(ii) **High Definition (HD) PTZ cameras**

Image Device	1/2.8-1/3" Progressive scan CMOS
Lens	4.45-4.7 /89-94.0 mm focal length
Optical Zoom	20x or better
Digital Zoom	12x or better
Number of Pixels/Effective resolution	1920X1080 (Full HD)/2 MP at 25/30 IPS
Video compression	H.264 Main Profile/High profile
Sensitivity(at 6dB)	color mode 0.6 lux , B/W mode 0.04lux @30IRE, F1.6
Horizontal Angle of view	55.4 deg(wide)- 3.5 deg (Tele) minimum
Focus	Auto with Manual Override
Iris Range	F1.6-F2.9
Iris Control	Auto with Manual Override
Back Light Compensation	Required
White Balance	Automatic with mode selection options
Electronic Shutter	1/50 to 1/10000 Auto
S/N Ratio	>50dB
Audio	Full Duplex or 2-way
Automatic Gain Compensation	Up to 18 dB
Power Supply	As per manufacturer's standard to be arranged by contractor
Gain Control	Auto/Off
Day/Night selection	Auto On-Off

IR cut-filter	Yes
Protocols	IPV4/IPV6,RTP, UDP, TCP, IP, HTTP, HTTPS, FTP, DHCP, IGMP V2/V3, ICMP, ARP, SMTP, SNTP,SNMP or equivalent.
Security	Password protection
Auto Resume after Power Failure	Yes
Multiple Streams Operating resolution	H.264 /H.264 & H.264/Motion JPEG Primary stream – 1920X1080 at 25/30 FPS & other minimum 720X576 at 25/30FPS
Analytics	Motion detection & Tamper alarm
PoE supply IEEE 802.3af compliant or better	Yes
Rate Control	VBR/CBR
Other Features	
	On screen Menu display, contour correction and contrast compensation control
	Automatic Picture Enhancement to give a balanced picture where there is too much/too little light
	Synchronization selection for line lock and free running
	Minimum 2 Alarm I/Ps & 1 alarm output
PTZ Specifications	
Pan	360 Deg Continuous
Tilt	90 deg
Manual Tilt Speed	0.1 deg/sec to 45 deg/sec
Manual Pan Speed	0.1 deg/sec to 80 deg/sec
Preset Positions	Minimum 256
Preset Pan Speed	280 deg/sec min
Preset Tilt Speed	160 deg/sec min

b) High Definition(HD) Fixed Camera

Image Device	1/2.8-1/3” Progressive scan CMOS
Number of Pixels	1920X1080 (Full HD)/2 MP at 25/30 IPS

	Sensitivity(at f1.2,6dB)	0.21 Lux color & 0.05 Lux B/W(at 30IRE)
	Lens	Varifocal Lens f=8-50 mm, CS-Mount
	Lens Mount	CS-Mount
	Focus	Auto with Manual Override
	Iris Range	1.6 to 360
	Audio	Full Duplex or 2-way
	IR cut-filter	Yes
	Protocols	IPV4/IPV6,RTP, UDP, TCP, IP, HTTP, HTTPS, FTP, DHCP, IGMP V2/V3, ICMP, ARP, SMTP, SNTP,SNMP or equivalent
	Security	Password protection,
	Iris Control	Auto with Manual Override
	Analytics	Motion detection & Tamper alarm
	PoE supply IEEE 802.3af compliant	Yes
	SD/SDHC/SDXC in Camera (For Local alarm recording & scheduled local recording)	Yes ,minimum 32 GB capability
	Rate Control	VBR/CBR
	Back Light Compensation	Required
	White Balance	Automatic with mode selection options
	Electronic Shutter	1/50 to 1/10000 Auto
	S/N Ratio	>50dB
	Automatic Gain Compensation	Up to 18 dB
	Power Supply	As per manufacturer's standard to be arranged by contractor
	Gain Control	Auto/Off
	Day/Night selection	Auto On-Off
	Other Features	
		On Screen Menu Display, contour correction and contrast compensation control
		Automatic Picture Enhancement to give a balanced picture where there is too much/too little light
		Synchronization selection for line lock and free running

	Minimum One Alarm I/P Minimum One Alarm O/P

4.03.00 Camera Housing& Mounting:

All the cameras and accessories are to be housed in Weather Proof IP 65 environmental housing made of aluminum and Sun shroud. The housing, with heater and blower installed, shall provide protection for camera/lens assemblies in the ambient temperature range of - 0 deg. C to 50 deg. C.

For Non Dome type cameras, the housing shall also have thermostatically controlled heater kit. Continuous duty blower kit (with suitable filters) for purge air arrangement / Window wipers shall be available within the housing for cameras as indicated against each application.

The camera mount should be of the same make as that of camera and suitable for the model no. offered as specified by the manufacturer and should be an integrated unit

4.04.00 Keyboard & Joystick, workstation & network switch :

Keyboard shall have full function used for system control and programming for selection of various Network switches, camera/database servers, camera functions including pan, tilt and zoom lens controls and shall be ergonomically designed. Joystick shall be provided for achieving all control functions.

Further, Work **Station, database server for Camera & network switches shall comply to specification indicated in other sub-sections of the specifications.**

4.05.00 CABLES:-

Cables shall be of FRLS PVC sheathed cables for use in CCTV and shall conform to latest edition of Indian/International standards. Fiber optic cables are to be provided as applicable. The remaining cables can be as per CCTV supplier's standard. For details of Fiber Optic cables, refer subsection INST CABLE. All the cables and the hardware required for powering the system are also in the scope of Contractor.

SUB–SECTION – IIIC-12

Type test Requirements

1.00.00	**TYPE TEST REQUIREMENTS**
1.01.00	General Requirements
1.01.01	The Contractor shall furnish the type test reports of all type tests as per relevant standards and codes as well as other specific tests indicated in this specification. If the bidder proposes a different standard/code from that indicated at table 3.00.00, same is acceptable provided the equivalence of the proposed standard is established by the bidder. A list of such tests are given for various equipment in table titled 'TYPE TEST REQUIREMENT FOR C&I SYSTEMS' at the end of this chapter and under the item Special Requirement for Solid State Equipments/Systems. For the balance equipment instrument, type tests may be conducted as per manufactures standard or if required by relevant standard.
1.01.02	As mentioned against certain items, the test certificates for some of the items shall be reviewed and approved by the main Bidder or his authorized representative and the balance have to be approved by the Employer.
1.01.03	The schedule of conduction of type tests/ submission of reports shall be submitted and finalized during pre-award discussion.
1.01.04	The Bidder shall indicate in the relevant BPS schedule, the cost of the type test for each item only for which type tests are to be conducted specifically for this project. The cost shall only be payable after conduction of the respective type test in presence of authorize representative of Employer. If a test is waived off, then the cost shall not be payable.
2.00.00	**SPECIAL REQUIREMENT FOR SOLID STATE EQUIPMENTS/ SYSTEMS**
2.01.00	The minimum type test reports, over and above the requirements of above clause, which are to be submitted for each of the major C&I systems shall be as indicated below: i) Surge Withstand Capability (SWC) 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 37.90.1/ IEEE-472. Hence, all front end cards which receive external signals like Analog input & output modules, Binary input & output modules etc. including power supply, data highway, data links shall be provided with protections that meets the surge withstand capability as defined in ANSI 37.90.1/ 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 EN 61000-4-18 which is equivalent to ANSI 37.90.1/ IEEE-472 may also be adopted for SWC test. ii) Dry Heat test as per IEC-68-2-2 or equivalent. iii) Damp Heat test as per IEC-68-2-3 or equivalent. iv) Vibration test as per IEC-68-2-6 or equivalent.

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

vi) Radio frequency immunity test as per EN 61000-4-6 or equivalent.

vii) Electromagnetic Field immunity as per EN 61000-4-3 or equivalent.

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

Type test report shall be provided for following items:-

Transducers, electrical metering instruments, opacity monitor, instrumentation cables, DC power supply, UPS, batteries, control valves & flow elements.

For reports the following is applicable.

i) The same has been carried out by the Bidder/ sub-vendor on exactly the same model /rating of equipment.

ii) There has been no change in the components from the offered equipment & tested equipment.

iii) The test has been carried out as per the latest standards along with amendments as on the date of Bid opening.

In case the approved equipment is different from the one on which the type test had been conducted earlier or any of the above grounds, then the tests have to be repeated and the cost of such tests shall be borne by the Bidder/ sub-vendor within the quoted price and no extra cost will be payable by the Employer on this account.

SUB–SECTION – IIIC - 13

STEAM AND WATER ANALYSIS SYSTEM (SWAS)

STEAM AND WATER ANALYSIS SYSTEM (SWAS)

1.00.00 STEAM AND WATER ANALYSIS SYSTEM (SWAS)

1.01.00 The purity of the condensate, feed water, steam etc. shall be continuously monitored through online analysis system. The on-line chemical analysis for pH, conductivity, , silica, dissolved oxygen, etc. shall be carried out in the plant cycle at strategic points. The exact sample points, their location, type of chemical analysis to be carried out for each sample, measurement ranges etc., shall be subject to the approval of the Employer. The system shall be designed in accordance to the recommendations of latest versions of ASME PTC 19.11, ASTM D 1066, ASTM D 3370 and ASTM D 5540.

1.02.00 The Contractor shall provide the chemical analysis system as a composite system including sample piping, valves, grab sample collection facility, gauges/indicators, coolers, on-line analyzers etc. The SWAS shall include the following meeting the technical requirement as indicated herein.

1.03.00 The Contractor shall be fully responsible on system basis, for proper engineering, selection of hardware, manufacture, testing, installation, commissioning and satisfactory functioning of complete and fully operational steam and water analysis system meeting the intent of this specification. All system components and accessories required for completeness of this system shall be furnished by the Contractor although these may not be individually specified herein. All system components shall be completely assembled, piped, wired and tested at the factory and shall be ready for installation when received at the project site.

1.04.00 All piping, tubing, fittings and other wetted parts in the sampling and analyzing system shall be of 316SS type or other suitable material for the service approved by the Employer. No plastics or rubber shall be permitted except within analysers as furnished by the manufacturer.

1.05.00 Information and alarm signal from SWAS system including analyzers/monitor output signals, chiller system etc. shall be hooked up to DDCMIS for monitoring purpose.

2.00.00 SWAS PANELS

2.01.00 The SWAS panels shall comprise of two panels viz. Secondary Sample Conditioning Panel (Wet Panel) and Analyser Panel(Dry Panel). Secondary Sample conditioning panel (Wet Section) shall house bulk head type fittings, removable cartridge type filters, pressure reducing elements, flow rate control, secondary coolers, grab sample valve and other sample conditioning equipments. For each sample, pressure gauge, temperature gauge, flow indicator, back pressure regulating valve, grab sample valve shall be provided on front of panel. The grab sampling facility and quick disconnect patch board facilities shall be provided on this panel.

2.02.00 Analyzer Panel (Dry Section) shall house cells, analyzers etc.

2.03.00 The above panels shall be physically separate from each other and shall be mounted in the air-conditioned SWAS room located at 0.0m level. . Secondary Sample conditioning panel shall be corridor type with walkway construction with side doors & removable type plate at the back. The analyzer panel shall be free standing & totally enclosed construction with back doors. The panels shall be constructed of 2.5mm thick steel plates except for doors, which shall be of 2.0mm thickness. The panel floor shall be made of 316 Stainless Steel Sheet of 5mm thickness with central flat portion for walk way and slightly sloping sections towards front and rear side and a panel drain. The waste water/sample from panel drain shall be piped to the nearest plant drain. The foundation details, layout and general arrangement of these panels shall be subject to Employer's approval.

2.03.00 **SAMPLE CONDITIONING SYSTEM**

2.03.01 The sample conditioning system shall provide samples at 25°C or a preset temperature required by the analyzer within tolerance of ±1°C, at a pressure of about 2kg/cm2 and at flow rates as required by individual analyzers/streams. Sample line to analyzer elements shall incorporate an anti-siphon design to prevent possibility of running dry because of a broken or plugged sample line. All fittings, tubes & other wetted parts shall be 316SS.

2.03.02 Sample conditioning system shall be designed and constructed to receive and condition all samples as required by the respective analyzers connected to the sample streams. This will include all conditioning as specified herein and shall cover the followings:

a) Primary sample cooling (wherever specified) in the field.

b) High pressure reduction (wherever specified) in the field.

c) racks shall be provided per unit by the Contractor for mounting primary coolers and high pressure reducing elements–in the field along with all required piping, fittings, and accessories. The exact grouping and location of these racks shall be as finalized during detail engineering stage.

d) Sample filtering.

e) Secondary sample cooling and temperature control.

f) Pressure reduction and control as required.

g) Flow rate control and measurement.

h) Other treatment as required by individual analyzers or as specified herein.

2.03.03 Primary cooling of all samples having temperature in excess of 45°C shall be provided through an individual sample cooler (primary cooler) with SS316 body, submerged helical coil type of shell and tube design with removable shell. The primary coolers shall use condensate quality (DM) plant equipment cooling water. The design, construction materials and technical features of the cooler shall be subject to Employer’s approval. However, the sizing of the coolers should consider total sample flow plus 500ml/min grab sample & a fouling factor of 0.2. The capacity calculation shall be subject to Employer's approval during detailed engineering. All the pipes, fitting & valves required for cooling water for the primary coolers (supply and return lines) from Employer’s tapping points shall be in Contractor’s scope. The Contractor shall also provide pipe from the waste drain header to the nearest building drain. Thermal protection devices as per ASME PTC 19.11 to be provided in the sample lines at the primary cooler outlets.

2.03.04 Each sample stream with the required flow rate shall be finally cooled to 25°C±1°C or to a preset temperature required by the analyzer through an individual secondary cooler before passing the sample to the respective measuring cells and analyzer even in case, the corresponding analyzer is rated for higher sample temperature. The secondary cooler shall also use condensate quality chilled water at 20°C. Chilled water for secondary cooler shall be provided by packaged refrigeration unit (chillers) to be furnished by the Contractor. The secondary coolers will also be of submerged helical coil type of shell and tube design with SS316 body.

2.04.00 **Chiller System**

(1) Two sets of 2x100% capacity water cooled chillers shall be provided by Contractor.

(2) Each chiller unit shall be designed with sufficient refrigeration capacity to ensure each sample stream temperature to 25°C±1°C when all streams are simultaneously at maximum flow rate and maximum temperature. The chiller capacity shall have a provision of 25% spare capacity for future samples. Suitable monitoring shall be provided for chiller o/l temp 20 dg C

(3) Chiller shall be of the direct expansion type with refrigerant tubes inside a shell, completely insulated and to be constructed in accordance with the ASME code for unfired pressure vessels.

(4) The chiller system shall be provided with 100% redundant chilled water pumps with suction and discharge pressure gauges and temperature gauges; Chilled water circulation pump with 100% standby facility; Storage tank automatic water make up with manual by-pass facility, temperature indicator, level gauge and drain and overflow connection, in addition to any other instruments/equipments required for smooth, convenient operation of the system, which shall also be furnished by the Contractor.

2.05.00 The Steam and Water Analysis system shall be provided with the sample shut off valves, blow down valves, solenoid actuated valves, pressure reducing valves, safety relief valves, back pressure regulating valves, high pressure reducing values etc. as indicated in diagram of SWAS The requirements of the important valves are specified as under:

(1) The sample shut off valves, blow down valves and pressure reducing valves shall have stellite spindle tip and shall be suitable for an operating pressure of 90 bars and an operating temperature of 400°C.

(2) The back pressure regulating valve shall be globe type shall be suitable for a pressure range of 0-50psi. The back pressure regulating valve shall consist of a range spring and a diaphragm assembly. The back pressure of the regulating valve is adjusted to the required set point by the range spring. In case of any excess pressure the diaphragm shall be lifted to release the excess pressure to maintain back pressure equal to the set value. Stainless steel trim with linear flow characteristics shall be provided Bidder shall submit the data sheet of these valves and these shall be subject to Employer's approval during detailed engineering stage..

2.06.00 all gauges, switches shall be provided as per Manufacturer’s standard & proven practice. Gauges, switches shall be as per specifications indicated in part-B

2.07.00 Grab Samples arrangement & sink connecting to nearest plant drain conforming SS pipes shall be provided .

3.00.00 **SPECIFICATION OF ANALYSERS**

Field proven reputed international make microprocessor based monitors/analyzers with LCD display and with necessary fault diagnostic features shall be employed. All analysers shall provide 4-20mA output signal capable of driving a load impedance of 500Ohms minimum. The type, size, capacity, material, make, model and other specification details of the rest of the SWAS system like coolers, gauges/switches, sample pipes, filter, pressure reducing elements, grab sampling arrangement, valves & fittings, panels etc. shall be as decided during detailed engineering stage and shall be subject to Employer’s approval. The power supply to all the analysers/ monitors shall be supplied by Contractor from his UPS system with all necessary switches, fuses, wiring/cabling and other required accessories etc. for distribution to individual requirements.

Minimum specifications of analyzers.					
Requirements	**Conductivity**	**PH**	**Silica**	**Dissolve oxygen**	

Type	For Hotwell, Two removable Type of Cells, For Others, Continuous Flow Through Type	Cell Flow Through sample	continuous calorimetric type	Continuous Flow Through sample	
Accuracy	≤ ± 1%	≤ ± 1%	≤ ± 5% of reading	≤ ± 5%	
Response Time (90 % of Full Scale)	≤ 5 sec.		≤ 16 min.	<30 sec	
Range	0-1, 0-10, 0-100 micro-mho/cm (freely programmable) for Specific Conductivity. 0-1 micro-mho/cm log scale for Cation conductivity	6-11 pH freely programmable	0-50,0-100,0-500 ppm freely programmable	0-20,0-200 ppb freely programmable	
Temperature Compensation	Automatic/	Automatic	Automatic	Automatic	
REMARKS	All the analysers/cells shall have open Corrosion resistant drain to waste header.				
	Analysers/ monitors/ cells shall be suitable for operating under the conditions specified.				

SUB–SECTION – IIIC - 14

ELECTRICAL ACTUATOR

1.00.00	**GENERAL:**
1.01.00	Actuators shall be designed for valve operation to ensure proper function in accordance with specifications given below and complying to EN15714-2 or equivalent. All standards, specifications and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions.
1.02.00	NOT USED
1.02.01	**NOT USED**
1.02.02	**NOT USED**
2.00.00	**COMMON REQUIREMENTS FOR NON INTRUSIVE ELECTRIC ACTUATORS**
2.01.00	**TYPE:**
2.01.01	The actuators shall have integral starters with built in SPP (Single Phasing Preventer). 415 V, 3 phase 3 wire power supply shall be given to the actuator from switch board 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.
2.01.02	The actuators shall be Non- Intrusive electric actuator. All actuator settings including torque, limit shall be possible without opening the actuator cover and LCD indication shall be available integral to actuator body.
2.02.00	**RATING:** (a) Supply Voltage & frequency: 415V +/- 10%, 3 Phase, 3 Wire & 50HZ +/-5%. (b) Sizing: Open/Close at rated speed against designed differential pressure at 90% of rated voltage. For ON/OFF type: Three successive open-close operations or 15 minutes, whichever is higher. For inching type: 150 starts per hour or required cycles, whichever is higher.
2.03.00	**CONSTRUCTION:** (a) Enclosure: Totally enclosed weatherproof, minimum IP-68 degree of protection. (b) Manual Wheel: Shall disengage automatically during motor operation.
2.04.00	**MOTOR:** (a) Type : Squirrel cage induction motor suitable for Direct On Line (DOL) starting. (b) Enclosure: Totally enclosed, self-ventilated. (c) Insulation

Class F. Temperature rise 70 Deg C. over 50 Deg C ambient.

(d) Bearings:

Double shielded, grease lubricated antifriction.

(e) Earth Terminals:

Two

(f) Protection:

Single Phasing Protection, Over heating protection through Thermostat (as applicable) 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.

2.05.00 POSITION/TORQUE TRANSMITTER:

The Position/ Limit measurement shall be done using absolute encoders which will give information of position/ limit in both the directions. Electronic measurement of torque shall be provided.

2.06.00 LOCAL OPERATION:

It shall be possible to operate the actuator locally also. Lockable local/remote selection shall be provided on the actuator.

2.07.00 LCD DISPLAY:

A local LCD display shall be provided to give information regarding actuator alarms, status and valve position indications as a minimum in local.

2.08.00 WIRING:

Suitable voltage grade copper wire.

2.09.00 TERMINAL BLOCK:

For power cables, the grade of TBs shall be minimum 650V.

2.10.00 ACCESSORIES:

All required accessories (if applicable) for calibration / settings/ configuration of various parameters of actuator shall be provided. For quantities, please refer Part A of technical specifications.

2.11.00 SIL CERTIFICATION:

All actuators shall be certified for SIL 2 or better.

3.00.00 SPECIFIC REQUREMENTS FOR NON INTRUSIVE HARDWIRED ACTUATORS

3.01.00 INTERFACES:

For ON-OFF and INCHING type actuators interface with the control system shall be through hardwired signal only.

(a) Open/Close command, open/ close status and disturbance monitoring signal (common contact for Overload, Thermostat, control supply failure, L/R selector switch at local & other protections operated) shall be provided hardwired.

(b) The actuator shall be able to accept open/close command at 24V DC with max. 2.5VA load from control system. Accordingly suitable isolated interface in the actuator shall be provided.

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

(d) For INCHING type actuators, hardwired analog position signal (4-20mA) derived from absolute encoder to be provided for actuator position.

3.02.00 TERMINAL BOX:

Suitable terminals/ connectors, integral to actuator, for terminating instrumentation & power cables shall be provided. Necessary glands for power cables and instrumentation cables shall be provided.

3.03.00 TRAINING:

Contractor shall provide training on Non-Intrusive hardwired Electric Actuator for Employer's personnel. The duration of the training shall be as elaborated in Part-C, Section-VI of technical specifications.

4.00.00 NOT USED

4.01.00 NOT USED

4.02.00 NOT USED

4.03.00 NOT USED

5.00.00 NOT USED